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TECHNICAL EVALUATION DEPARTMENT

EQUIPMENT EVALUATION DIVISION

ANALYSIS OF THE VIBRATION ENVIRONMENT FOR AIRBORNE RECONNAISSANCE INTEGRATED ELECTRONICS SYSTEM (ARIES) INSTALLED ON EP-3E AIRCRAFT

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NAVAL AVIONICS FACILITY

INDIANAPOLIS, INDIANA 46218

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Environmental Sciences Branch
Test Report

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ANALYSIS OF THE VIBRATION ENVIRONMENT FOR AIRBORNE RECONNAISSANCE INTEGRATED ELECTRONICS SYSTEM (ARIES) INSTALLED ON EP-3E AIRCRAFT

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PREFACE

The continuation of failures of various components, mainly the Traveling Wave Tube (TWT), Lower Rotary Joint Assembly, and Pedestal Bearings, of the Big Look Antenna Assembly, AS-2879/APS, part of the Big Look Antenna System, OE-157A/APS, which is a part of the Airborne Reconnaissance Integrated Electronics System (ARIES), resulted in NAVAIR contacting Naval Avionics Facility, Indianapolis (NAFI) with regard to the acquisition of additional vibration data in support of the ARIES Program. The Environmental Sciences Branch 443 was requested by NAFI Program Manager D/905 to acquire vibration data for analysis during Flight Tests at NAS Moffett Field, Mountain View, California during the period of 9 through 19 July 1974.

The acquisition of vibration data during the Flight Tests at Moffett Field was for the purpose of (1) obtaining additional data for the Big Look Antenna Assembly installed in several EP-3E Aircraft for analysis and comparison with the vibration data acquired during previous Flight Tests[1] at Hayes International, Birmingham, Alabama, and (2) to acquire vibration data not only at locations that were used during previous Flight Tests, but also at locations selected as a result of the analysis performed on the previously acquired data. In addition, the representative for the manufacturer of the Big Look Antenna System, United Technology Laboratories (UTL), also requested that vibration response data be obtained at selected locations.

Analysis of this data was performed during the interim of July 1974 to March 1975. This analysis was interrupted three separate times to support other data acquisition and test efforts for the ARIES and Deepwell Programs. Per NAVAIR's request, NAFI acquired vibration response data for some components of the Deepwell System during Flight Tests at NAS Fallon, Nevada. Also during this period, special evaluations were performed in the laboratory on the Deepwell Tape Recorder (refer to Environmental Sciences Branch 443 Report ESL-157 dated 14 March 1975) and Lower Rotary Joint Assembly (refer to Environmental Sciences Branch 443 Report ESL-162 dated 31 March 1975 and Failure Analysis Laboratory Report 12016-FA-74-48J).

This report describes the Flight Tests, the data acquisition methods, the data analysis procedures, the results obtained from the analysis and comparison of the vibration data, and the recommended vibration specifications for the Big Look Antenna System and components of the Antenna Assembly that were derived from the vibration data obtained during the Flight Tests.

Funds for conducting the acquisition and analysis of the vibration data were provided by NAFI Job Order 1652-1.

[1] Analysis of the vibration data obtained during Flight Tests at Hayes International is detailed in Environmental Sciences Branch Report ESL-135 dated 17 June 1974.

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I. CONCLUSIONS

1. Problems that have been occurring within the Big Look Antenna Assembly during the field environment have been suspected to be vibration related. Analysis of the vibration data obtained during the Flight Tests does not definitely confirm those suspicions, but the analysis does indicate that vibration levels measured at some locations are severe enough to contribute to those problems.

2. Vibration responses measured at the monitored locations are complex in nature containing both periodic components (sinusoidal vibration) and broadband noise (random vibration). The combination of the sinusoidal components and the random vibration are occurring simultaneously throughout the flights of the EP-3E Aircraft and these combinations are continually varying within each Aircraft. This field environment is considerably different than the procurement specifications. The present specifications for qualification in the laboratory require only swept-sinusoidal vibration from 5 to 500 Hz with only a single frequency being excited at any one instant. Thus, the present vibration specifications not only disregard the fact that a "resonance dwell" condition exists at the predominate sinusoidal frequencies of the Aircraft for the entire duration of each flight, but also the random vibration that is present during the flight. In addition, some of the sinusoidal responses that were measured during the Flight Tests exceed the present specifications. Consequently, components which are "qualified" may not be able to withstand the field environment. Therefore, any failures, related to the vibration environment, that are presently occurring in the field may have been prevented if the components had been qualified to vibration requirements that are more representative of the field environment.

3. Analysis of the vibration data obtained from the monitored locations during all Flight Tests indicates the following:

a. The primary sinusoidal frequencies (68, 136, 204, and 272 Hz) are present for all three Aircraft.

b. The sinusoidal and random responses vary between the different Aircraft.

c. The amplitudes of certain sinusoidal components for both the Traveling Wave Tube (TWT) and Feedhorn Coupler exceed the specified sinusoidal qualification levels for these components.

d. The TWT is placed in a "twisting" or "bending" mode, which probably results in stresses occurring to components within the unit.

e. Neither position, up or down, of the Big Look is more or less severe than the other.

f. Sectoring the Antenna ± 10° from the center line of the Aircraft resulted in no significant differences in the responses as compared with the responses obtained with the Antenna stationary.

II. RECOMMENDATIONS

1. Inasmuch as the problems occurring during the field environment have not definitely been concluded to be the result of the vibration environment, it is recommended that Failure Analysis be performed on any component which incurs failure in the field environment. In this regard, NAFI has the capability for performing the required Failure Analysis[1].

2. Since vibration data at different locations on the Big Look Antenna Assembly have been acquired and analyzed to provide information relative to the field environment, it is recommended that this information, by way of the recommended vibration requirements specified herein, be implemented for future procurement of components utilized in the Big Look Antenna Assembly[2]. In addition to the qualification of the individual components, it is also recommended that a complete Big Look Antenna Assembly be qualified in the laboratory to the recommended vibration requirements, specified herein.

3. The vibration requirements specified herein take into account the probable changes in the mechanical responses within the Big Look Antenna Assembly as a result of the proposed modifications. However, to insure that the field environment for the components and Antenna Assembly is not more severe than the specification requirements, herein, it is recommended that, after the laboratory qualification of the Big Look Antenna Assembly, vibration data be acquired from the Flight Tests of the first installation for comparison with the specification requirements and previous flight data. Thus, if the modifications to the Big Look Antenna Assembly or the installation of the modified unit results in excessive or unexpected vibration levels being encountered, then the necessary actions to resolve the discrepancies could be taken.

[1] A Lower Rotary Joint returned from the fleet was subjected to a Failure Analysis, see Failure Analysis Laboratory Report 12016-FA-74-48J, which concluded the failure to be humidity related.

[2] A program to modify the Big Look Antenna Assembly is presently in progress.

III. BACKGROUND INFORMATION

The acquisition and analysis of vibration data obtained during actual flight conditions of the Big Look Antenna Assembly, AS-2879/APS, (herein referred to as the Big Look), part of the Airborne Reconnaissance Integrated Electronics System (ARIES), was necessitated by: (1) numerous malfunctions which have occurred in the past and are presently occurring to the Traveling Wave Tube (TWT), Lower Rotary Joint Assembly, and Antenna Pedestal Bearings, and (2) the need to correlate data, obtained from these flights with data obtained during previous flights, to determine the variation, if any, of vibration characteristics exhibited by different EP-3E Aircraft that have the ARIES installed.

Acquisition of vibration data was previously obtained during Flight Tests at Hayes International, Birmingham, Alabama, during the period of 15 through 19 April 1974. These Flight Tests were performed using one EP-3E Aircraft (G5, Bureau No. 150502) with the flight profiles, such as take-offs, landings, radome up/down, and props. in and out of sync., controlled by Hayes, thus limiting both the quantity and type of data that could be acquired. Information relative to the Flight Tests performed at Hayes is available in Environmental Sciences Branch 443 Report ESL-135 dated 17 June 1974. From the analysis of the vibration data acquired at Hayes, it was possible to determine some worse case conditions so that these conditions could be concentrated on more thoroughly by changing the flight profiles - within limitations, monitoring additional locations suspected to have problems that could be vibration related, and changing the type of analysis, if necessary, to provide a more thorough evaluation for the Flight Tests described in this report.

The Big Look and the TWT each have specific qualification vibration requirements. For the Big Look the qualification test levels are in accordance with MIL-E-5400, Curve I. The test levels are detailed in FIGURE I of APPENDIX A. The qualification test levels for the TWT are in accordance with MIL-E-5400, Curve III and are detailed in FIGURE II of APPENDIX A.

IV. DISCUSSION

A. DATA ACQUISITION

Instrumentation provided to acquire vibration data for the Big Look Antenna Assembly (Position 24), refer to FIGURE I of APPENDIX B for the general location, during the three flights described in this report included: (a) five triaxial accelerometers with the same axis of each accelerometer being recorded simultaneously; (b) five charge amplifiers operating on 115 V.A.C., 60 Hz power from the aircraft electrical system; and (c) two portable tape recorders, both operating on 115 V.A.C., 60 Hz power from the aircraft electrical system, each with three FM channels for recording data and one direct channel for recording voice. The charge amplifiers and tape recorders were located between Position 29 (Radioman Station) and Position 17 (Navigator Station), refer to FIGURE I of APPENDIX B for the general location. A discussion of the three flights is detailed in the following paragraphs.

1. Aircraft G3 (Bureau No. 150501)

a. Flight No. 1 - This flight, performed on 11 July 1974, was an eight-hour, Sylvania contractual flight consisting of a take-off, flying to and from the range, flying at altitude, and landing. During this flight, vibration data were recorded at locations Pedestal (A), Feedhorn Assembly, Feedhorn Coupler Assembly, Isolation System, and the Radome (refer to FIGURE II of APPENDIX B for detailed accelerometer locations and axis definitions) in three axes (X, Y, and Z) under varying flight conditions. These flight conditions included take-off and landing, flying at altitude, radome up and down with props. in and out of sync. for each, and radome coming up and going down.

b. Flight No. 2 - This flight was from NAS Moffett Field to NAS Alameda on 15 July 1974. Although the distance was relatively short, the duration of the flight was dependent upon the completion of the data acquisition. The accelerometers were relocated for this flight to Pedestal (A), Pedestal (B), TWT (A), TWT (B), and the Elevation Drive Assembly (refer to FIGURE II of APPENDIX B for detailed locations and axis definitions).

The vibration data was obtained while flying in a delta pattern around Moffett Field at an altitude of approximately 2,000 feet and an Indicated Air Speed (IAS) of approximately 170 KTS. The same flight conditions, which were performed during Flight No. 1 were also performed for this flight. Additional data were acquired during the flight to Alameda with the Antenna sectoring $\pm$ 10° from the Aircraft heading at a 6 rpm rate. This rate for sectoring the Antenna was recommended by Mr. George Albin, UTL representative, as the ultimate and most severe operation of the Antenna. However, upon completion of acquiring vibration data at a 6 rpm sectoring rate and to keep from damaging the Big Look, the sectoring rate was decreased to 4.5 rpm. The Big Look was also sectored at a rate of 1 rpm to obtain information for analysis to determine possible wearing characteristics relative to the Pedestal bearings.

2. Aircraft G2 (Bureau No. 150497) - This flight, performed on 19 July 1974, was an eight-hour, Sylvania contractural flight with the acquisition of data limited to one take-off and landing, and flying at altitude at the various test conditions. Accelerometers were installed to monitor the X, Y, and Z axes at locations Pedestal (A), Pedestal (B), TWT (A), and TWT (B), while only one accelerometer, monitoring the Z axis, was installed on the Radome. The accelerometer locations are detailed in FIGURE II of APPENDIX B.

B. DATA ANALYSIS

1. Procedure

The four data analysis techniques used for the investigation of the previously acquired vibration data were also used for the analysis of the vibration data acquired during the Flight Tests performed at NAS Moffett Field. These same techniques were necessary due to the varying types of data present and for correlation with the data previously obtained. A brief description for each of the analysis techniques is detailed below.

Averaged Time History - This type of analysis provides an overall view of broadband acceleration levels as a function of the flight conditions, thus assuring that the portion of data selected for the remaining analysis exhibited the most significant vibration response levels. To perform this type of analysis for all data acquired from Flight Tests, approximately 350 graphs were obtained. A typical Averaged Time History Analysis is illustrated in FIGURE I of APPENDIX C.

Time Domain Analysis - This type of analysis allows for an analysis of the selected periodic data, based on the results of the Average Time History and provides an output of peak levels which is a representation of the actual periodic data. This analysis required the acquisition of approximately 500 graphs. A typical Time Domain Analysis is illustrated in FIGURE II of APPENDIX C.

Frequency Domain Analysis - This type of analysis provides a power spectral density (PSD) of selected portions of data. This technique allows assessing the frequency dependence of the vibration signals and also provides a method of observing the amplitudes and frequencies of any random vibration present. Frequency Domain Analysis was accomplished using a 4 Hz filter and 32 averages over the frequency range of 10 to 2000 Hz. Approximately 500 PSD graphs were obtained to perform this analysis. A typical Frequency Domain (PSD) graph is illustrated in FIGURE III of APPENDIX C.

Filtered Peak Time History - This type of analysis, by using a selected filter bandwidth, provides an output which represents the response at a particular frequency with respect to time. For this analysis, the selected portion of data, as determined by the Averaged Time History Analysis, was swept through a 10 Hz filter, centered at the frequency of the desired periodic signal, e.g. the 10 Hz filter centered at 68 Hz with the resultant analysis covering the frequencies of 63 to 73 Hz. For this analysis, the random vibration at the selected periodic signal was not considered. Thus, the output of this analysis is a time history of the peak response level at the periodic frequency. Approximately 200 graphs were obtained to perform this analysis (refer to APPENDIX F for illustrations of this type of analysis).

Thus, as can be seen from the above discussion, analysis of the vibration data recorded during fleet operations is complex and requires considerable effort. Over 1,500 graphs of the vibration data were obtained to assist in the evaluation of the vibration environment experienced by the Big Look Antenna Assembly and its components.

Since a large number of graphs were obtained to perform the required analysis of the vibration data, not all of the graphs are included in this report. Thus, to illustrate each type of analysis, the sample graphs were included. However, any information deemed important relative to understanding the vibration environment or supporting the discussion presented herein, is included.

2. Results

The results discussed in the following paragraphs include analysis of the sinusoidal and random responses obtained from the

Flight Tests reported herein, and for comparison, the results of the data obtained during Flight Tests at Hayes International, Birmingham, Alabama, which was reported in Environmental Sciences Branch 443 Report ESL-135 dated 17 June 1974[1]. The corrections detailed in the footnote do not affect any conclusions or recommendations that were made in the ESL-135 report, but instead strengthen them. The results obtained from all Flight Tests are discussed in the following paragraphs.

a. Sinusoidal Vibration Responses

In general, the analysis of vibration data obtained from all Flight Tests indicates that the vibration responses, measured on three Big Look's, each installed on a different EP-3E Aircraft (G2, G3, and G5), exhibit the predominate frequencies (68, 136, 204, 272, and 340 Hz) of the EP-3E Aircraft. These responses contained more power and occurred more frequently at particular locations than others. In addition, the magnitude of the responses in certain directions along with the frequency, not only varied with each Aircraft and the flight conditions, but in some instances, varied between Aircraft during the same flight conditions. It should be noted that the Big Look is responding to these predominate frequencies throughout the entire flight, which in turn represents a long duration dwelling at these particular frequencies. In addition, the phasing of frequencies could be such that, at times, the responses at each frequency would combine to provide a response level of significant magnitude which may also exceed any levels detailed in this report. Although determination of the cause for the differences in responses between Aircraft is not impossible, the number of variables which are or could be present makes this task a very difficult one and additional information would be required. Thus, a definite conclusion as to these differences will not be attempted. However, the differences of responses between Aircraft could be the result of any one or any combination of the following variables.

1. Each Aircraft has a different flight crew which may result in the take-offs and landings being different.

2. Synchronization of the propellers for each Aircraft may vary.

3. Possible differences between the four engines of each Aircraft.

4. Installation of the Big Look on the different Aircraft may vary.

[1] Subsequent to the release of the ESL-135 report, an error was discovered in the software analysis program that was supplied with the Digital Analysis System, which results in the Maximum Power Spectral Density Peaks of TABLE II in Environmental Sciences Branch 443 Report ESL-135 being low by a factor of 2 and the Sinusoidal Levels of APPENDIX D of the same report being low by a factor of 1.414.

5. The Big Look may respond differently in each Aircraft.

6. The position of the Radome (up or down) may result in different vibration responses.

7. The mechanical responses of each Aircraft may vary slightly, thus resulting in the Aircraft generating higher or lower vibration levels.

As indicated by the above list of variables, which is probably only a partial list, a substantial number of variables are involved which may result in the difference of responses. Therefore, this report will deal only with those differences without attempting to rationalize their cause.

Analysis of the vibration data obtained from the Flight Tests performed with the G2 and G3 EP-3E Aircraft indicates that the sinusoidal response levels measured at TWT (A) and the Feedhorn Coupler exceeded the vibration level specified by FIGURE I and II of APPENDIX A. TABLE I shows the maximum vibration responses (peak g level) at each monitored location, with the frequency and axis for this maximum response also included, for each of the three Aircraft.

TABLE I

MAXIMUM PEAK RESPONSES

Accelerometer Location	Aircraft (G2) Resp. (g)	Freq. (Hz)	Axis	Aircraft (G3) Resp. (g)	Freq. (Hz)	Axis	Aircraft (G5) Resp. (g)	Freq. (Hz)	Axis
Pedestal (A)	1.1	68	Z	1.5	68	X	-	-	-
Pedestal (B)	1.5	68	Z	1.4	68	Z	2.0	136	X
TWT (A)	7.0	68	Z	1.0	136	Y	4.2	136	Y
TWT (B)	2.0	68	Z	1.0	68	Z	-	-	-
Feedhorn Assy.	-	-	-	3.0	68	Z	2.7	68	Z
Feedhorn Coupler	-	-	-	10.5	272	X	-	-	-
Isolation System	-	-	-	5.5	68	X	6.0	204	Z
Radome	10.7	68	Z	-	-	-	9.7	136	Z

It should be noted that all locations were not monitored on each of the Aircraft and although not included in TABLE I above, all of the maximum peak response levels for G2 and G3 occurred during take-off with the exception of the levels measured for the Feedhorn Coupler, which occurred during the flight conditions of Radome up or down with the props. out of sync. for each. All of the maximum peak responses for Aircraft G5 occurred during the flight conditions of flying at altitude, Radome up or down with the props. in sync. for each, except the response measured on the Feedhorn Assembly, which occurred during take-off, thus, illustrating some of the variables that were previously mentioned.

Inasmuch as the vibration responses detailed in TABLE I represent the maximum response levels that were measured at each monitored location including the frequencies at which the response levels occurred, these responses along with the responses which are simultaneously occurring at the other predominate frequencies should be considered together before a conclusion is made. For example, as indicated in TABLE I, a maximum response level of 10.5g was measured on the Feedhorn Coupler at 272 Hz in the X axis. Also, although not included in TABLE I as a maximum response level, 9.7g was measured on the Feedhorn Coupler at 68 Hz, also in the X axis. Comparing the two responses, the 9.7g response at 68 Hz is probably more severe because of the lower frequency, which since the responses are approximately of the same magnitude, results in more displacement or movement. That is, the displacement (0.04 inch D.A.) at 68 Hz is approximately 10 times the displacement (0.003 inch D.A.) at 272 Hz, thus the response level at 68 Hz, although not a maximum acceleration response, could be more likely to cause component failures.

A different method of comparing the response levels at the predominate frequencies of the Aircraft and observing the variation of response levels between Aircraft is provided by the Bar Graphs detailed in APPENDIX D. The Bar Graphs expand TABLE I by presenting the maximum response levels in each of the three axes for each monitored location. Also included in the Bar Graphs are the predominate frequencies of the Aircraft and the flight condition the maximum responses occurred. Analysis of the Bar Graphs indicates that, generally, a comparison of the responses for each monitored location between the three Aircraft results in a variation of amplitudes and a variation of axes for which those responses occurred.

Analysis of the Bar Graphs also indicates that the response levels measured at TWT (A) for Aircraft G2 not only exceeds the qualification vibration input (detailed in FIGURE II of APPENDIX A), but is also approximately 3.5 times the maximum level measured at TWT (B), thus the TWT is apparently placed in a twisting mode, which would result in stress concentration throughout the TWT.

The data presented in the Bar Graph for the Feedhorn Coupler are limited to only Aircraft G3. The Feedhorn Coupler exhibited the maximum peak response for any component part of the Big Look, excluding the Radome. However, the response did not occur during take-off, but during the flight condition of flying at altitude, Radome up - props. in sync. The tables of maximum sinusoidal responses detailed in APPENDIX E can be used in conjunction with the Bar Graphs for comparison, interpretation, and obtaining the actual response levels.

Filtered Time History Curves were also plotted to provide a method of observing the variation of response levels for selected periodic frequencies at certain monitored locations with respect to time. The curves were obtained using a 10 Hz filter centered at the Aircraft frequencies of 68, 136, and 272 Hz. The Filtered Time History Curves for G2 and G3 Aircraft are detailed in APPENDIX F. Generally, the Filtered Time History Curves provide the following information:

a. The TWT (A) and Feedhorn Coupler locations both exhibit instantaneous peak responses of 11g.

b. The peak response levels measured at TWT (A) are approximately 2 to 3.5 times the peak response levels measured at TWT (B).

c. Based on the difference in response levels on the TWT, the TWT appears to be placed in a twisting or bending mode.

d. The peak responses between Pedestal (B) and TWT (A) are being amplified by a factor of 4.

b. Random Vibration Responses

Although the sinusoidal responses that were discussed in previous paragraphs are of a significant magnitude to justify concern, the random vibration that the Big Look is incurring should also be of concern, especially since the qualification specifications do not contain any requirements pertaining to random vibration. To illustrate, TABLE II contains the maximum random responses measured and the frequency at which the responses occurred for each of the monitored locations and, if applicable, the Aircraft on which the response occurred. These responses were obtained without considering the sinusoidal components.

TABLE II

MAXIMUM RANDOM RESPONSES

Accelerometer Location	Aircraft (G2) Resp. (g^2/Hz)	Aircraft (G2) Freq. (Hz)	Aircraft (G2) Axis	Aircraft (G3) Resp. (g^2/Hz)	Aircraft (G3) Freq. (Hz)	Aircraft (G3) Axis	Aircraft (G5) Resp. (g^2/Hz)	Aircraft (G5) Freq. (Hz)	Aircraft (G5) Axis
Pedestal (A)	0.016	380	Z	0.02	140	Z	-	-	-
Pedestal (B)	0.016	380	Z	0.004	1590 380	Y Z	0.0012	970	X
TWT (A)	0.046	380	Z	0.004	1100	X	0.016	110	Y
TWT (B)	0.006	150	Y	0.0014	340	Z	-	-	-

Accelerometer Location	Aircraft (G2) Resp. (g^2/Hz)	Freq. (Hz)	Axis	Aircraft (G3) Resp. (g^2/Hz)	Freq. (Hz)	Axis	Aircraft (G5) Resp. (g^2/Hz)	Freq. (Hz)	Axis
Feedhorn Coupler	-	-	-	0.72	380	X	-	-	-
Feedhorn Assy.	-	-	-	0.002	1710	Z	0.06	1370	Y
					500	X			
Isolation System	-	-	-	0.16	270	Z	0.16	310	Z
Radome	0.06	270	Z	-	-	-	0.08	150	Z

TABLE II only illustrates the maximum random response levels that occurred at each location. APPENDIX G contains tables of maximum random response levels for all three axes at each location. As can be seen in TABLE II, the random responses, in addition to the sinusoidal responses, are of significant levels to warrant concern. It should be noted that, as a result of the random components that occurred during flights with Aircraft G2 and G3, the data obtained during flights with Aircraft G5 were analyzed a second time with more emphasis placed on the random components at the lower frequencies.

3. Summary

By using the four types of analysis previously discussed to analyze the recorded vibration data and by comparing the results of that analysis, it was possible to determine the following:

a. The predominate frequencies, generated by the engines of the Aircraft, do not excite individual components within the Big Look in the same manner between Aircraft.

b. The sinusoidal levels measured on the TWT at 68 Hz for Aircraft G2 and 136 Hz for Aircraft G5 exceed the specified test levels.

c. The sinusoidal levels measured on the Feedhorn Coupler at 272 Hz exceed the test levels for the Big Look and also approach those test levels at 68 and 204 Hz.

d. The sinusoidal levels measured on both ends of the TWT differ significantly, thus the TWT is probably being placed in a "twisting" or "bending" mode, which can result in stresses within the TWT.

e. The random components of the vibration data for Aircraft G2 and G3 are generally of a significant level and frequency to warrant consideration.

f. The vibration data obtained from the three different Aircraft are not conclusive toward establishing a general procedure concerning positioning of the Radome during non-mission flights[1]. It is felt that data currently available doesn't indicate any certain pattern to establish a general procedure. However, it should be noted that if the concern for positioning of the Radome is relative to responses of the Aircraft, it is this writer's opinion that the vibration levels experienced near positions 17 and 29 of each Aircraft (G2, G3, and G5) seem to be less during flight with the Radome in the down position. This is not to say that the Radome in the down position is the best location relative to the components within the Big Look.

C. RECOMMENDED VIBRATION REQUIREMENTS

The ultimate method of simulating the vibration environment, as indicated by the composite graphs detailed in APPENDIX H, experienced by the Big Look Antenna Assembly during fleet operations would consist of subjecting the individual components, as well as the complete Big Look Antenna Assembly to a very complex vibration spectrum. As a minimum, the test spectrum would be comprised of four sinusoidal components at the primary Aircraft frequencies (68, 136, 204, and 272 Hz) and the random vibration, all occurring simultaneously.

As probably envisioned, to obtain the designated test spectrum would be very complex, since it would require four separate sinusoidal signals with each one tuned to one of the above mentioned frequencies and superimposed on the random response. However, generating the test spectrum in this manner does not provide true simulation of the vibration environment. The following constraints would also have to be included: (1) the sinusoidal components for true simulation would be required to be swept in a very narrow band around the primary frequency and (2) the phase relationship of the four sinusoidals would have to be continuously varying so that the amplitude of the composite signal would be constantly varying.

As can be seen by the above discussion, the problems encountered are complex, thus making repeatability, should the designated spectrum be generated, very difficult and time consuming, not only between different test facilities, but also within the same test facility. Therefore, it is recommended the individual components and the Big

[1] Subsequent to the acquisition and analysis of data obtained during Flight Tests at NAS Moffett Field, NAFI was requested by FAIRECONRON TWO by NTX R261305Z Mar. 75 to provide information relative to establishing procedures for positioning the Radome in the up/down position during non-mission flights. NAFI replied with NTX R331910Z Mar. 75 stating that additional analysis would be required to provide such information. However, as can be seen by the data presented in this report, many uncontrollable variables are involved in determining the positioning of the Radome.

Look Antenna Assembly be subjected to two Vibration Tests; one test simulating the sinusoidal components, and one which simulates the random responses. Thus, recommended test levels and spectrums for both tests were generated from composite graphs.

Each of the composite graphs contains all data obtained for that particular location during Flight Tests with each Aircraft, thus all flight conditions that were incurred during the Flight Tests are included in each of the graphs. This method of analyzing the data provides an overall view of how each location is responding during all conditions for all of the Aircraft (G2, G3, and G5). From the composite graphs, it is obvious that the primary Aircraft frequencies of 68 and 136 Hz are the most predominate for the majority of the monitored locations. To acquire the peak g level for a particular sinusoidal frequency, with no consideration for the random component, the following formula can be applied:

$$g \text{ peak} = \sqrt{(g^2/Hz) \times 8}$$

where:
g peak = sinusoidal level at the particular frequency
and
g^2/Hz = level of response at the particular frequency as obtained from the graph

Vibration spectrums for each monitored location were first generated from the composite graphs. Then for simplification, the spectrums were combined to provide spectrums for three (3) vibration zones. These three vibration zones are illustrated by the drawing in Enclosure (1) of APPENDIX I. A brief discussion for each of the zones is included below:

Zone A - This vibration zone refers to components mounted in or on the Pedestal. In addition, the zone represents one of the input zones for qualification of the complete Big Look Antenna Assembly.

Zone B - This vibration zone encompasses the remaining part of the Big Look, except for Zone C. This zone represents the second input zone for qualification of the complete Big Look Antenna Assembly.

Zone C - This vibration zone refers to components mounted near the same location as the Feedhorn Coupler.

The recommended test procedures and associated vibration curves for the sinusoidal and random vibration exposures are detailed in Enclosures (2) and (3), respectively, of APPENDIX I. These recommended procedures and curves, although generated from data obtained from the present Big Look Antenna Assembly configuration, have a reasonable safety factor included to allow for some vibration response changes that may occur as a result of modifications to the present Big Look Antenna Assembly configuration. It is felt that the recommended vibration requirements provide as true a representation as possible of the actual field environment and, at the same time, provide assurance that upon successful qualification to the recommended vibration requirements, the Big Look Antenna Assembly should experience successful operation during the field environment, provided the existing failures are vibration related.

For qualification of the complete Big Look Antenna Assembly, it is required that both sinusoidal and random responses be applied at the Pedestal and the Isolation System (not simultaneously) as defined below:

Pedestal Input - The Test Procedures, detailed in Enclosure (2) of APPENDIX I, would be the same procedures as used for qualification of the individual components mounted within Zone A. FIGURES IA and IIA, detailed in Enclosure (3) of APPENDIX I, would also be the applicable curves for performing the prescribed vibration exposures.

Isolation System Input - This input represents an input from the Radome, thus the Test Procedures, detailed in Enclosure (2), of APPENDIX I would be the same procedures as used for the qualification of individual components mounted within Zone B. FIGURES IB and IIB, detailed in Enclosure (3) of APPENDIX I, would also be the applicable curves for performing the prescribed vibration exposures.

APPENDIX A

SPECIFIED VIBRATION INPUTS

FIGURE I - VIBRATION TEST LEVELS FOR ANTENNA ASSEMBLY (AS-2879/APS) PER CURVE I OF MIL-E-5400 FOR CLASS IA EQUIPMENT

FIGURE II - VIBRATION TEST LEVELS FOR TRAVELING WAVE TUBE (TWT) PER CURVE III OF MIL-E-5400

FIGURE I - VIBRATION TEST LEVELS FOR ANTENNA ASSEMBLY
PER CURVE I OF MIL-E-5400 FOR CLASS IA EQUIPMENT

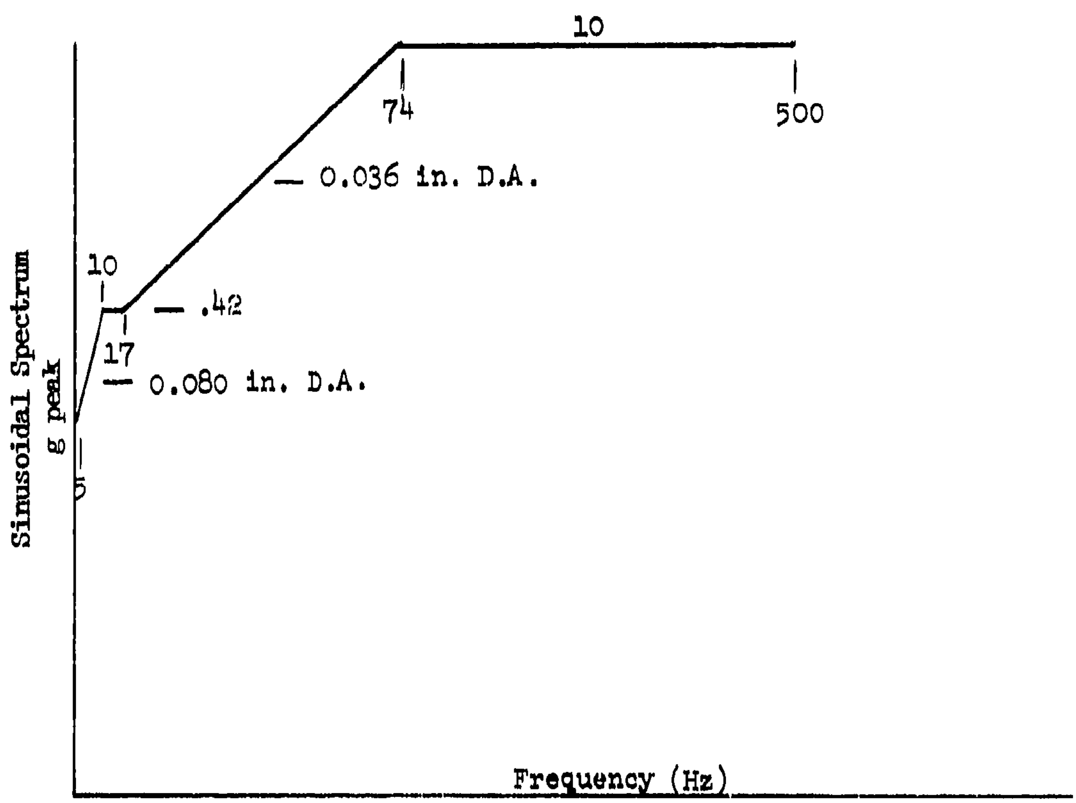
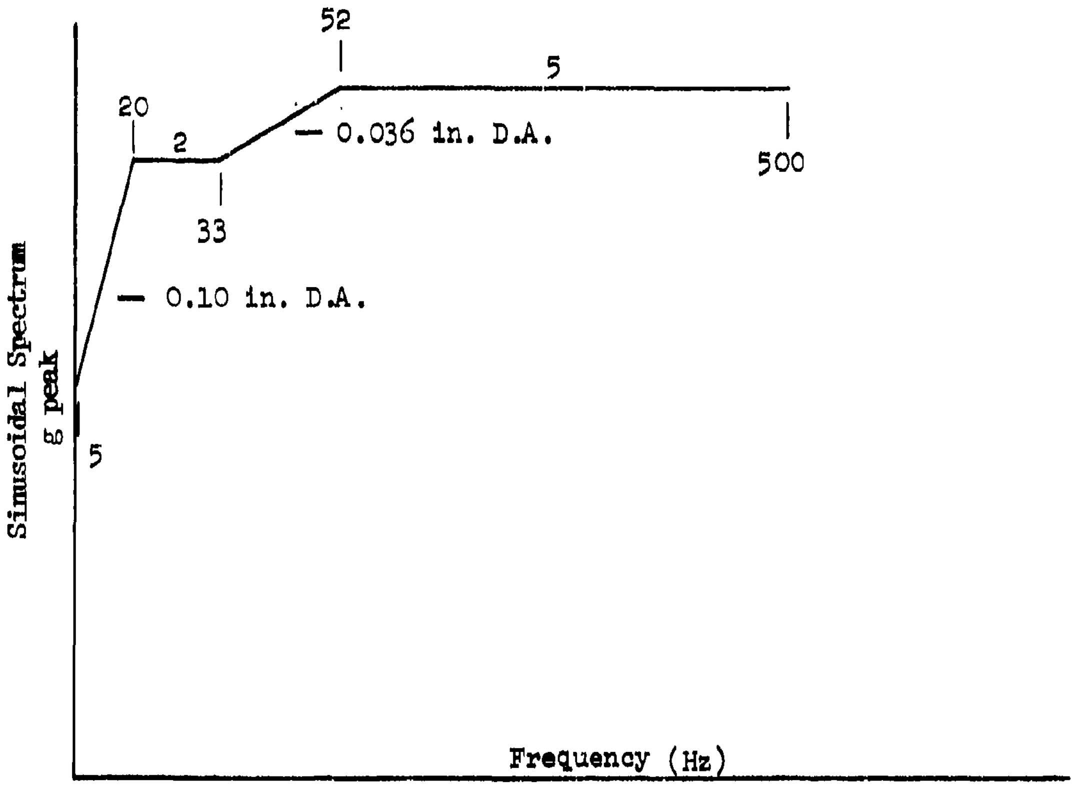


FIGURE II - VIBRATION TEST LEVELS FOR TRAVELING WAVE TUBE (TWT) PER CURVE III OF MIL-E-5400



APPENDIX B

DRAWINGS SHOWING AIRCRAFT LAYOUT AND ACCELEROMETER LOCATIONS

FIGURE I - AIRCRAFT LAYOUT

FIGURE II - BIG LOOK ANTENNA ASSEMBLY (POSITION 24)

FIGURE I - AIRCRAFT LAYOUT

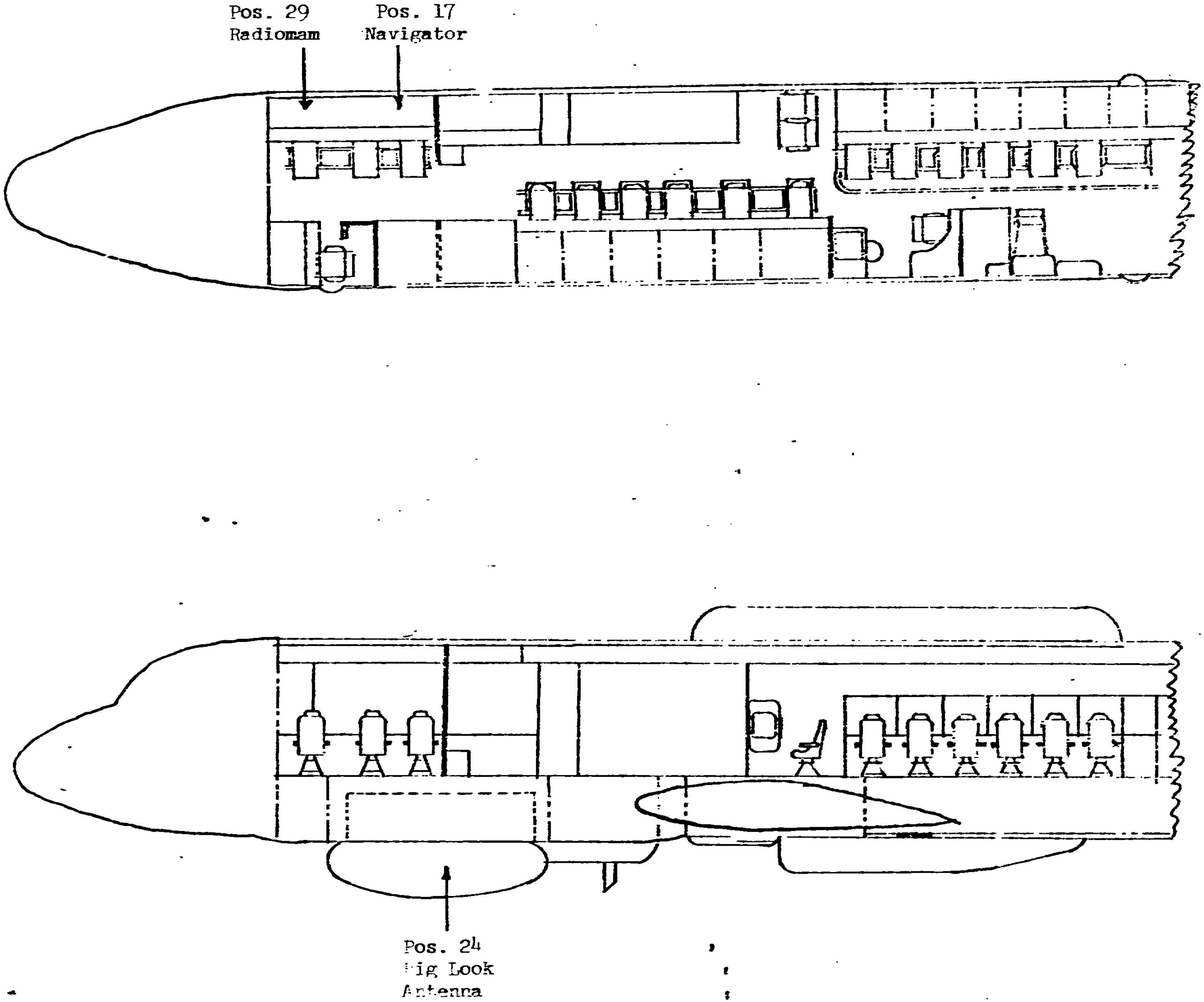
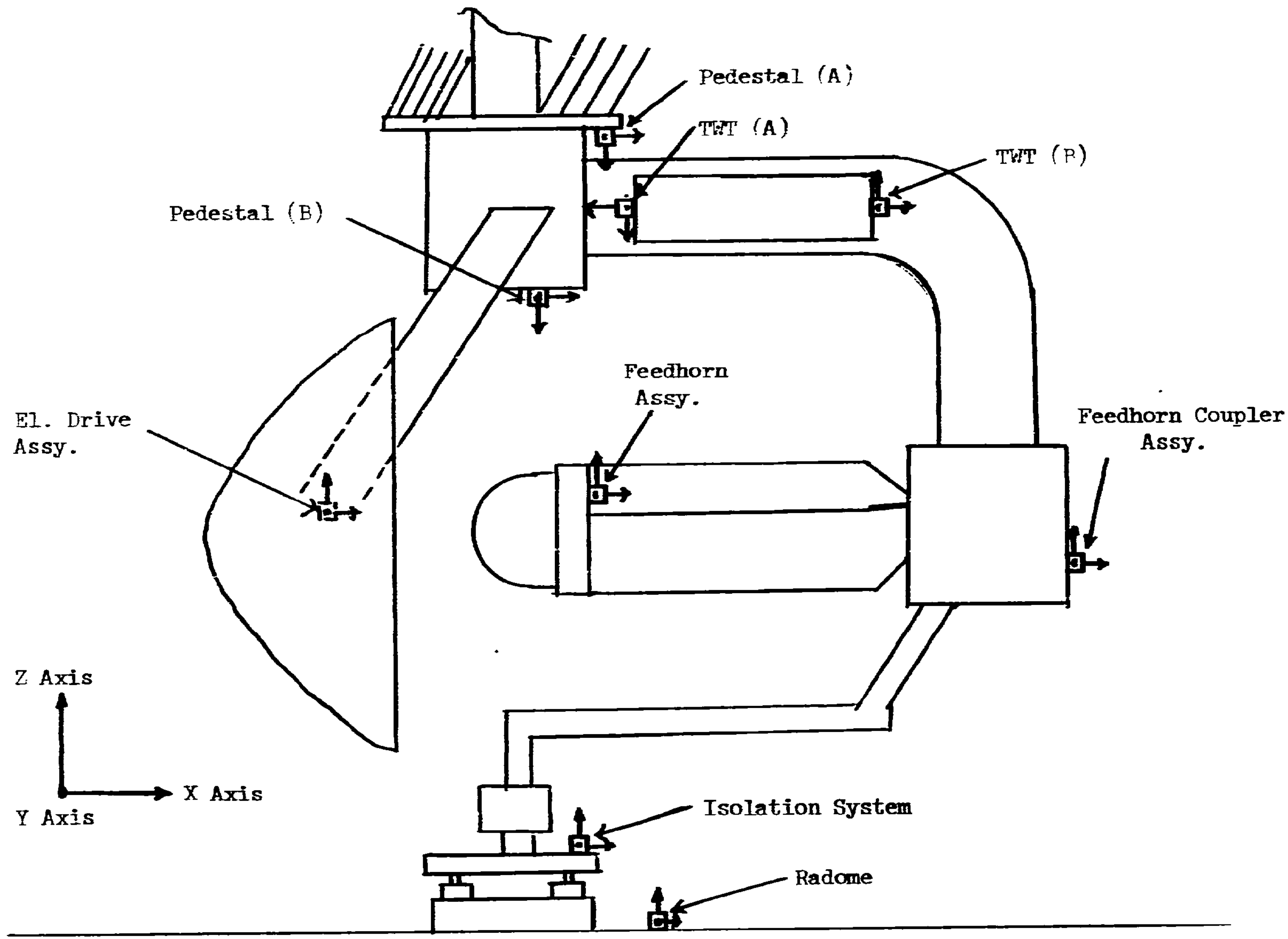


FIGURE II - PIG LOOK ANTENNA ASSEMBLY (POSITION 24)



APPENDIX C

TYPICAL ANALYSIS GRAPHS

FIGURE I - TYPICAL AVERAGED TIME HISTORY ANALYSIS

FIGURE II - TYPICAL TIME DOMAIN ANALYSIS

FIGURE III - TYPICAL FREQUENCY DOMAIN ANALYSIS

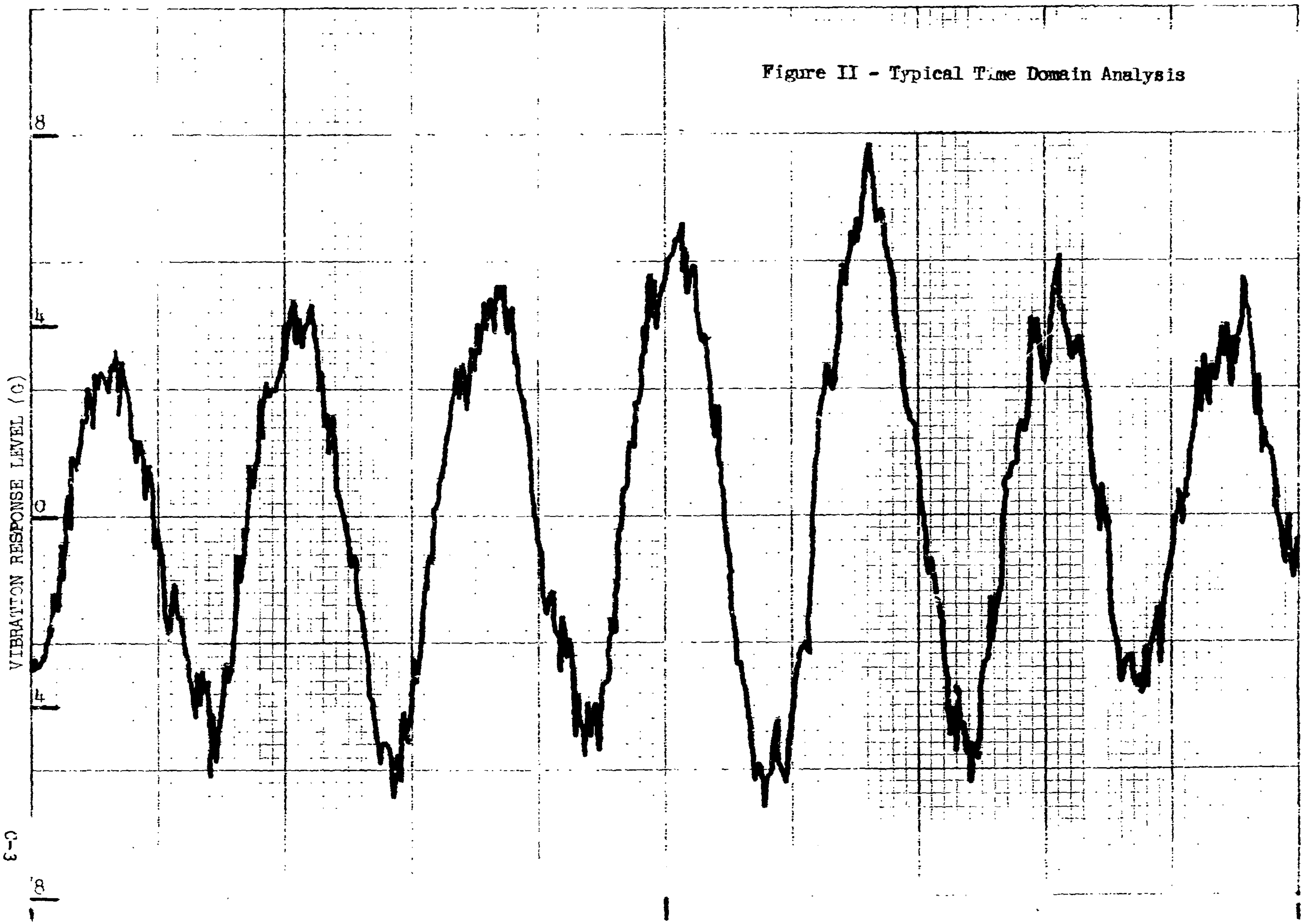


Figure II - Typical Time Domain Analysis

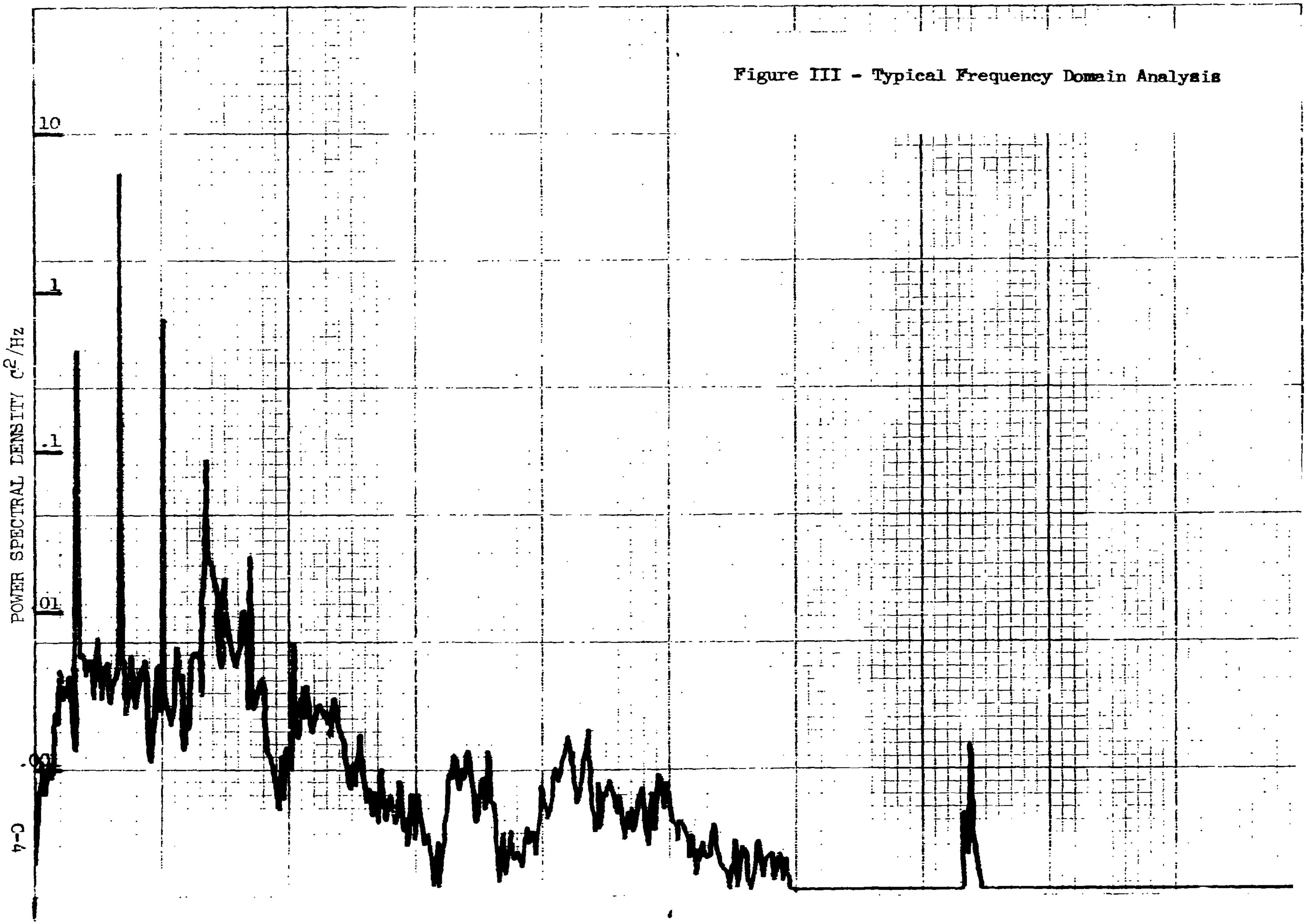


Figure III - Typical Frequency Domain Analysis

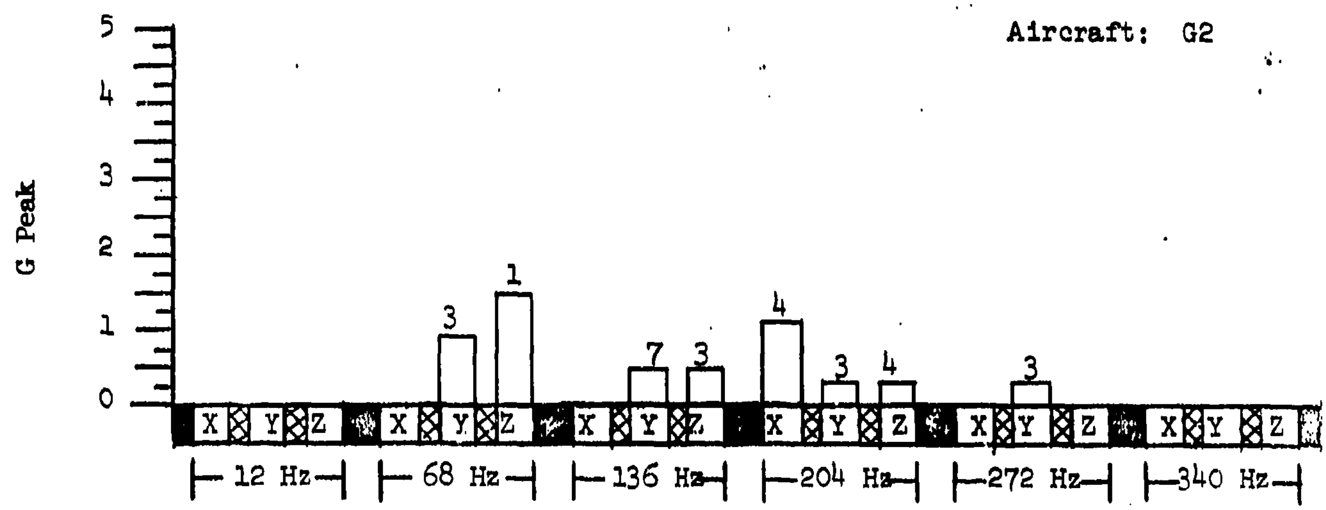
APPENDIX D

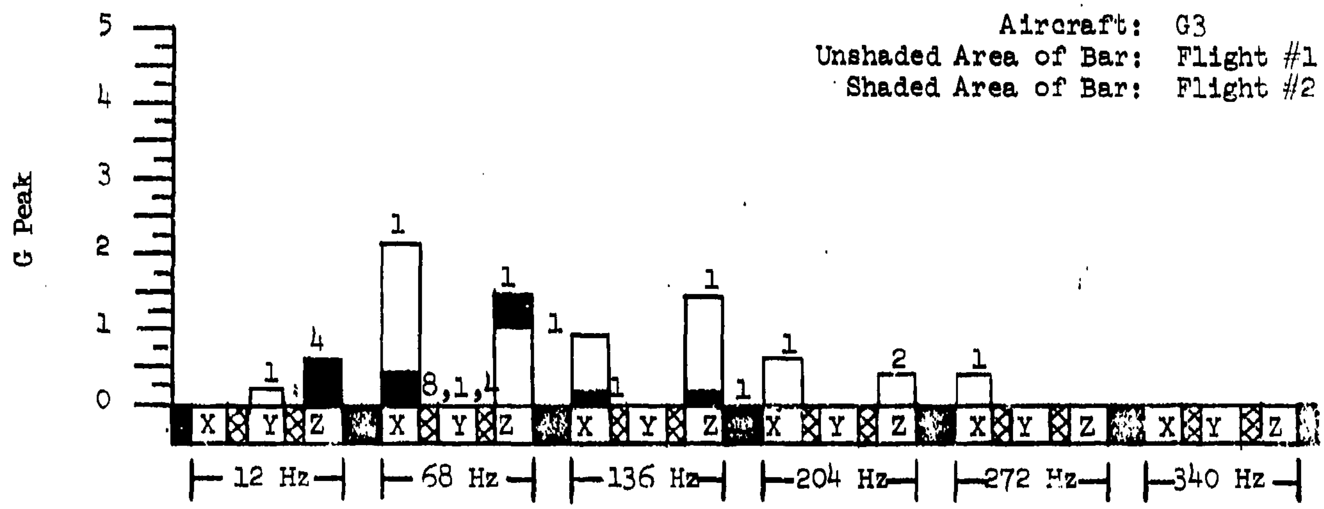
BAR GRAPHS SHOWING MAXIMUM G LEVELS

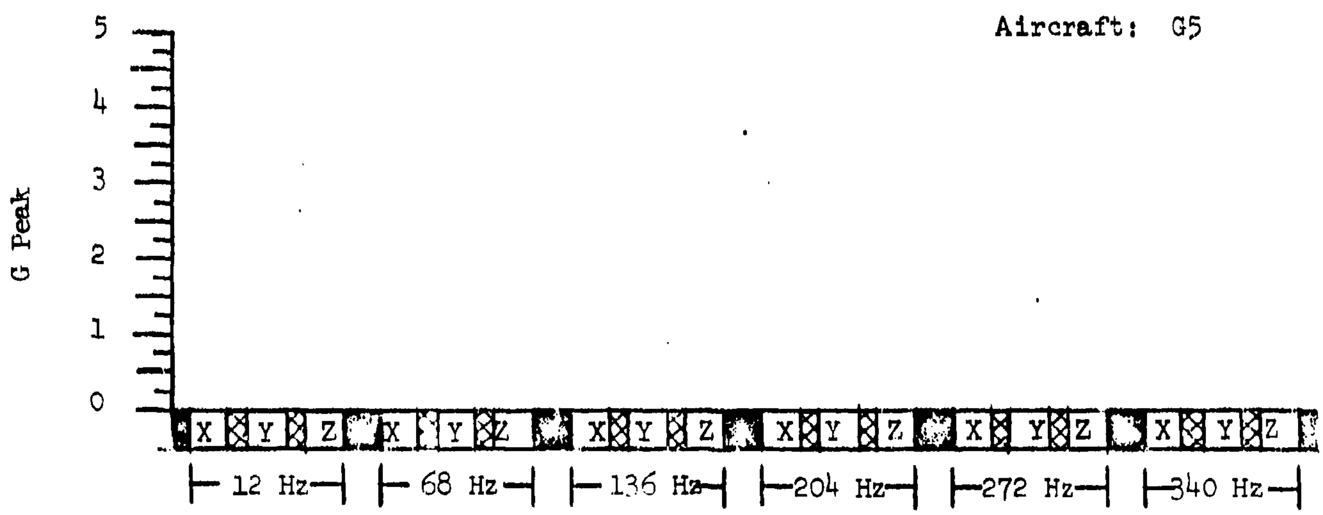
The vibration data contained in these graphs were obtained during different flight conditions. The flight condition for each response level is indicated above each level by a number designation. The flight conditions are listed below:

F/C 1 - Take-off, Pitch applied to Props
F/C 2 - Flying at Altitude, Radome up, Props in Sync.
F/C 3 - Flying at Altitude, Radome up, Props out of Sync.
F/C 4 - Flying at Altitude, Radome going down, Props in Sync.
F/C 5 - Flying at Altitude, Radome down, Props in Sync.
F/C 6 - Flying at Altitude, Radome down, Props out of Sync.
F/C 7 - Flying at Altitude, Radome coming up, Props in Sync.
F/C 8 - Landing, Reverse Pitch applied to Props
F/C 9 - Taxiing after Touchdown

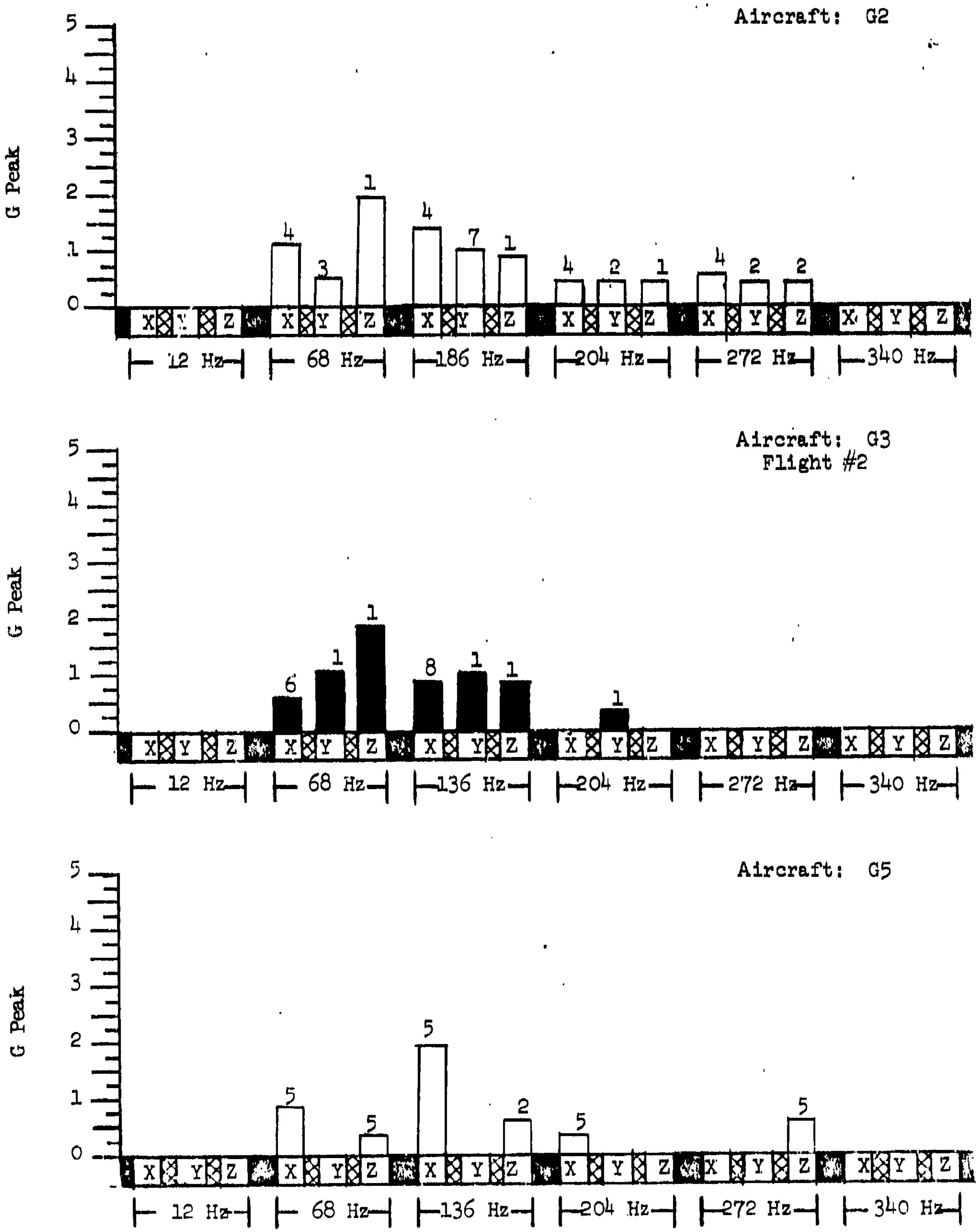
MAXIMUM G RESPONSES
PEDESTAL (A)



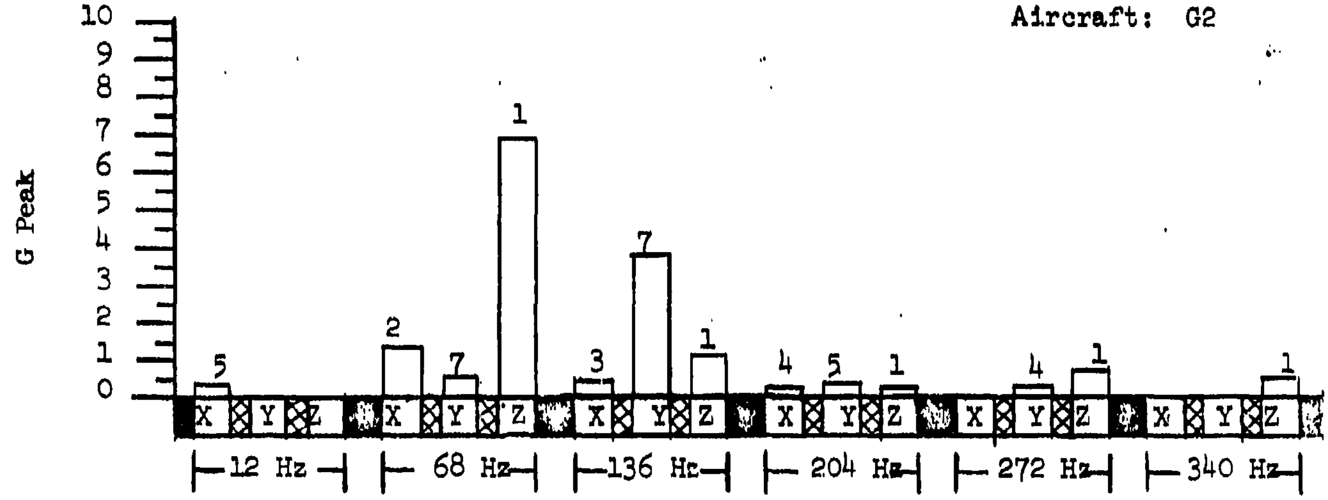


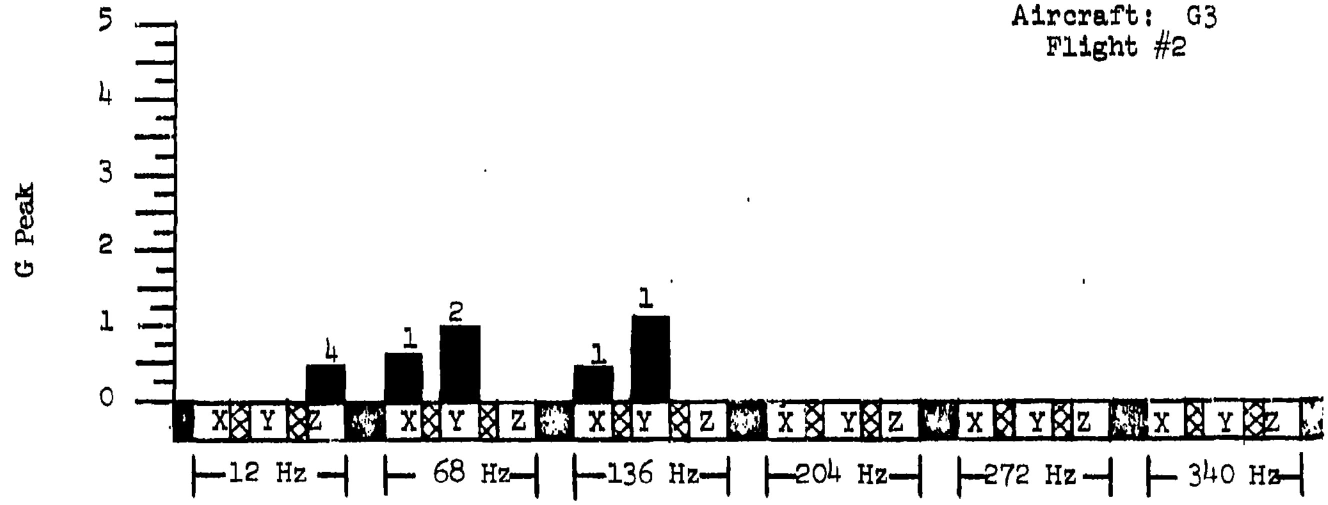


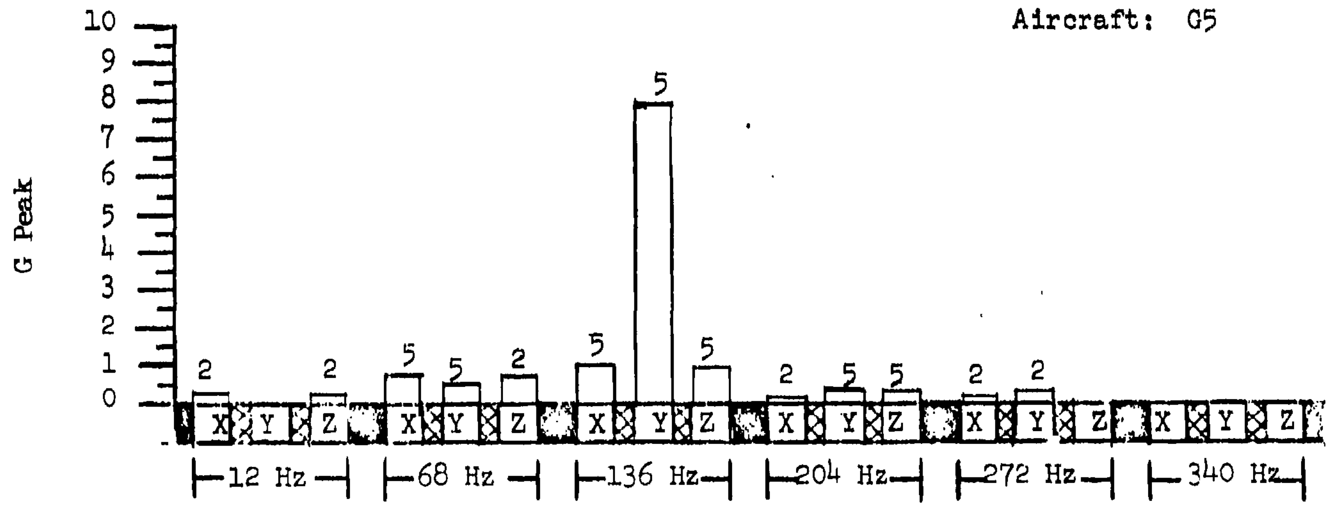
MAXIMUM G RESPONSES
PEDESTAL (B)



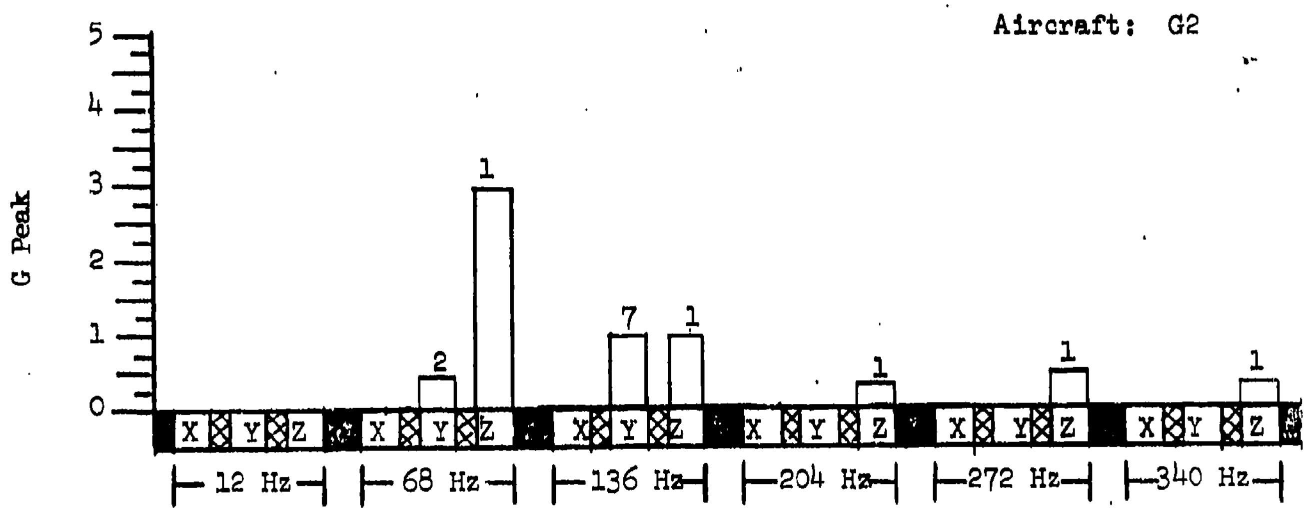
MAXIMUM G RESPONSES
TWT (A)

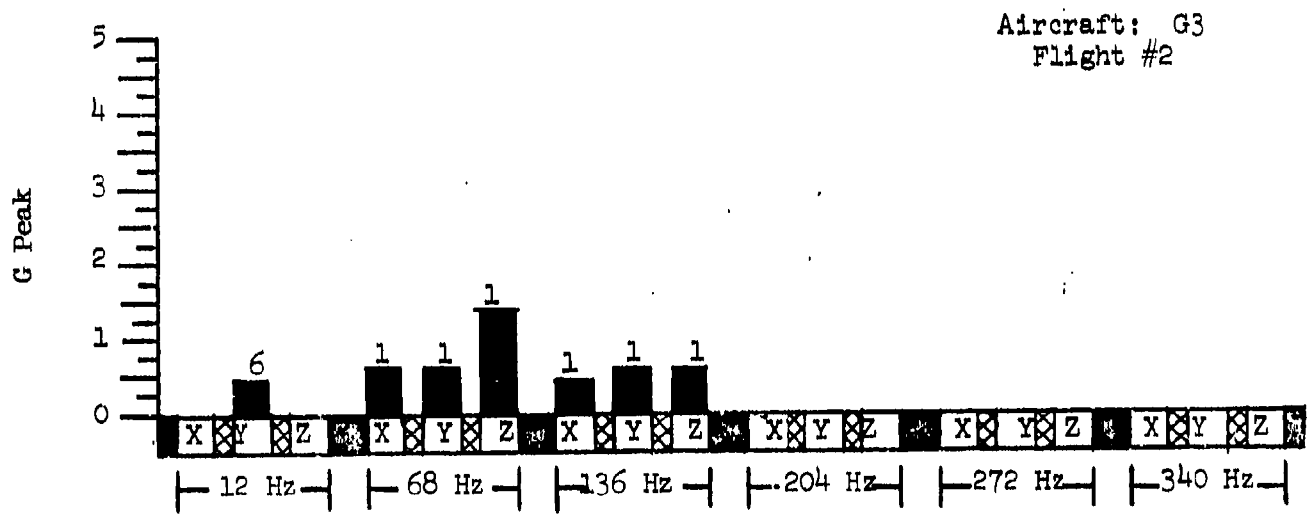


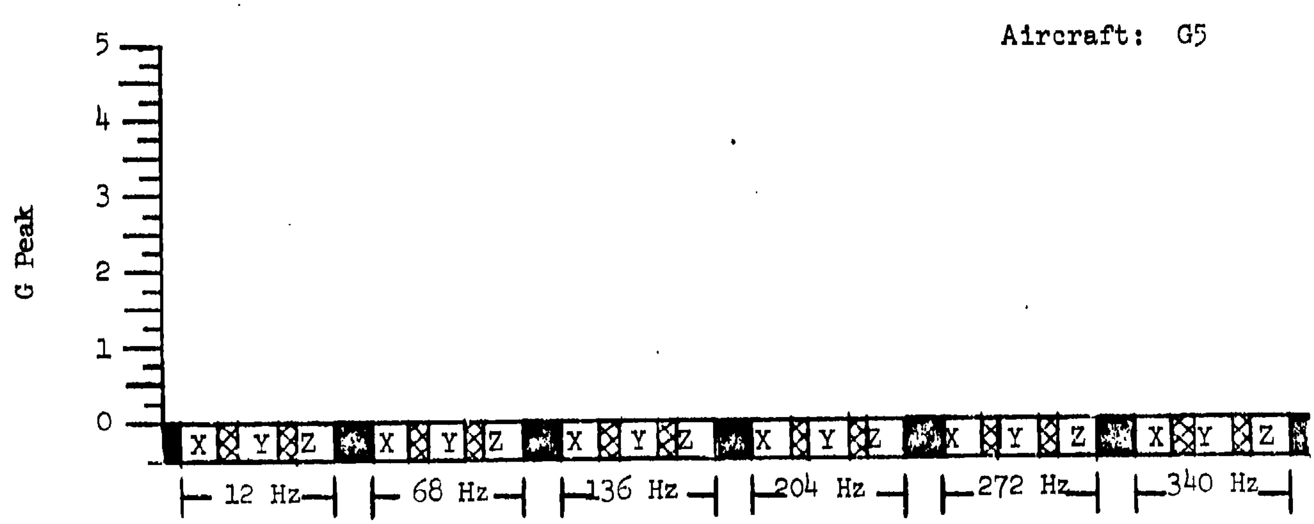




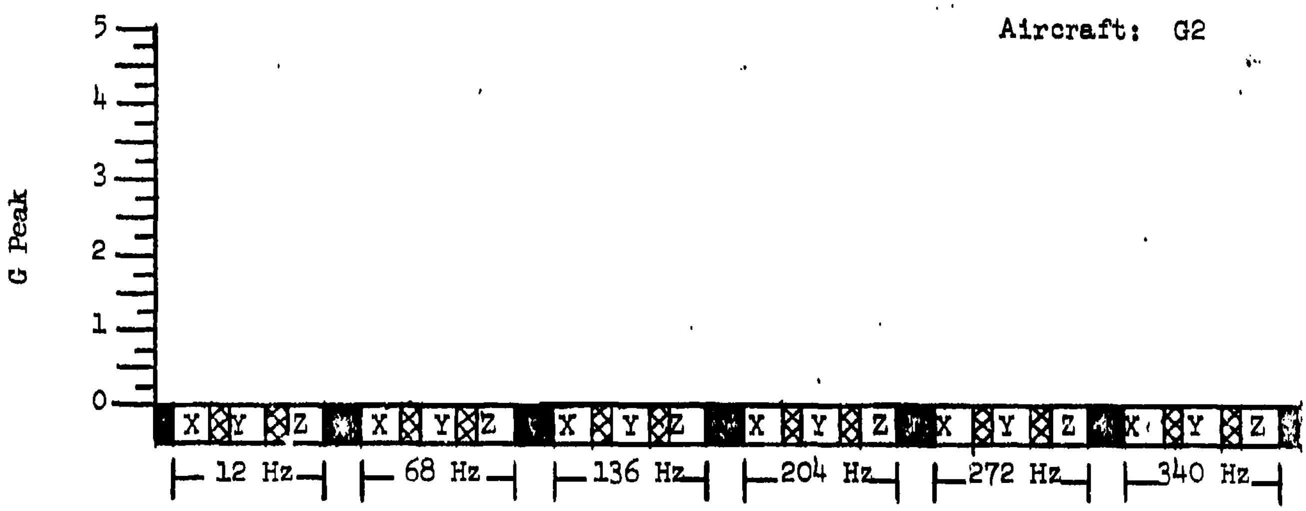
MAXIMUM G RESPONSES
TWT (B)

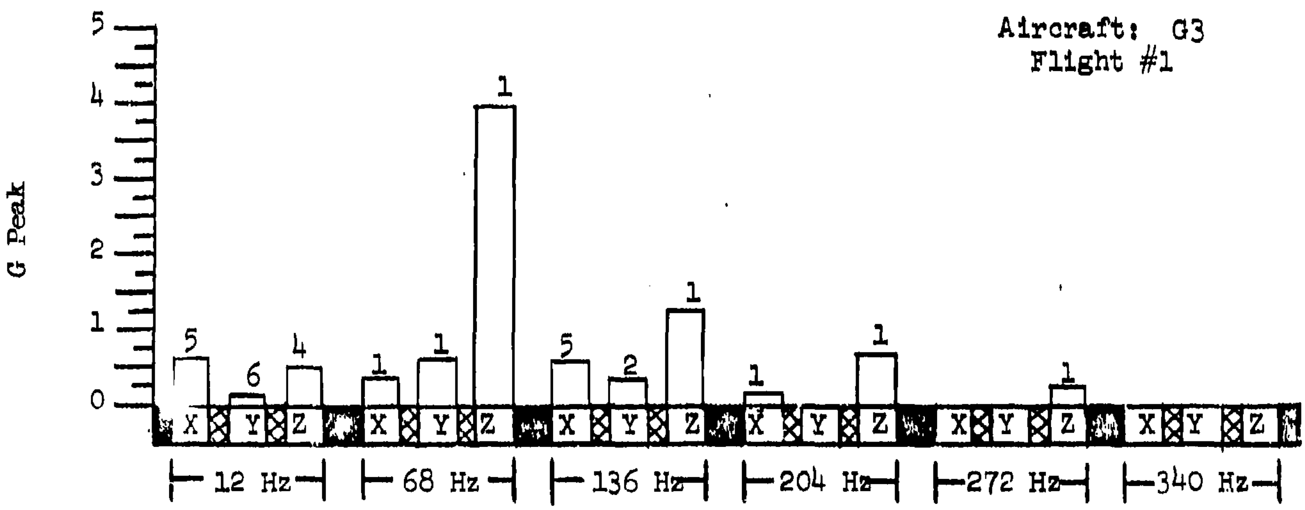


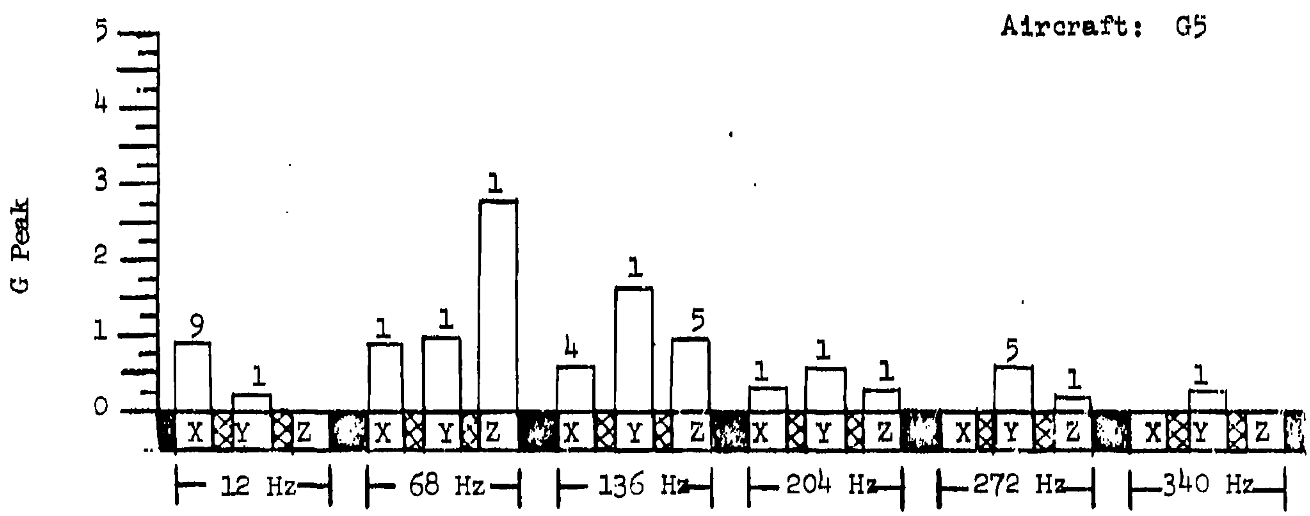




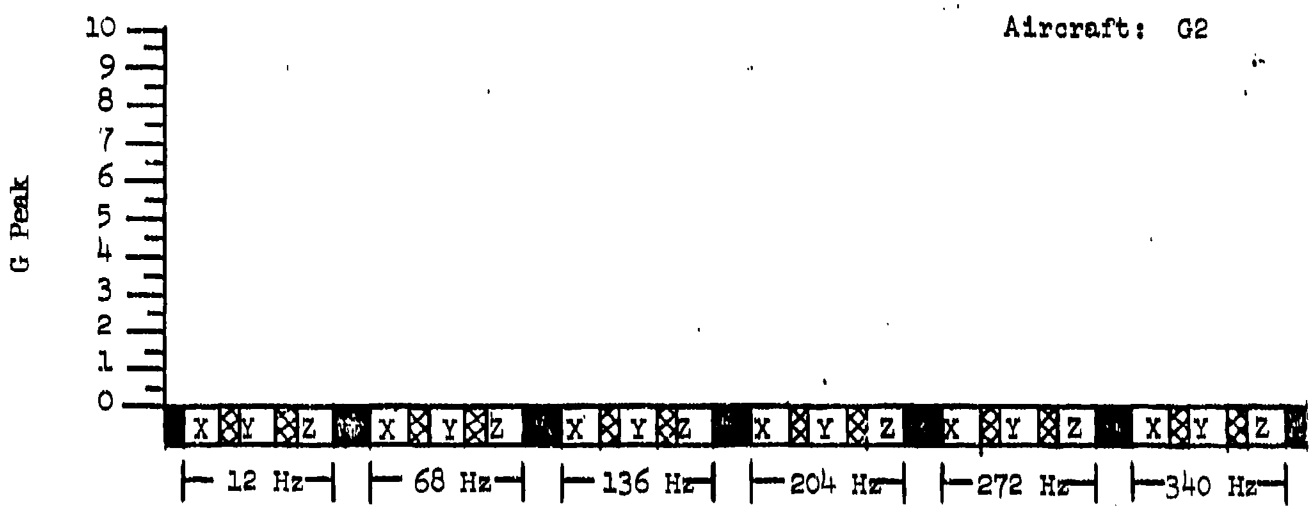
MAXIMUM G RESPONSES
FEEDHORN ASSEMBLY

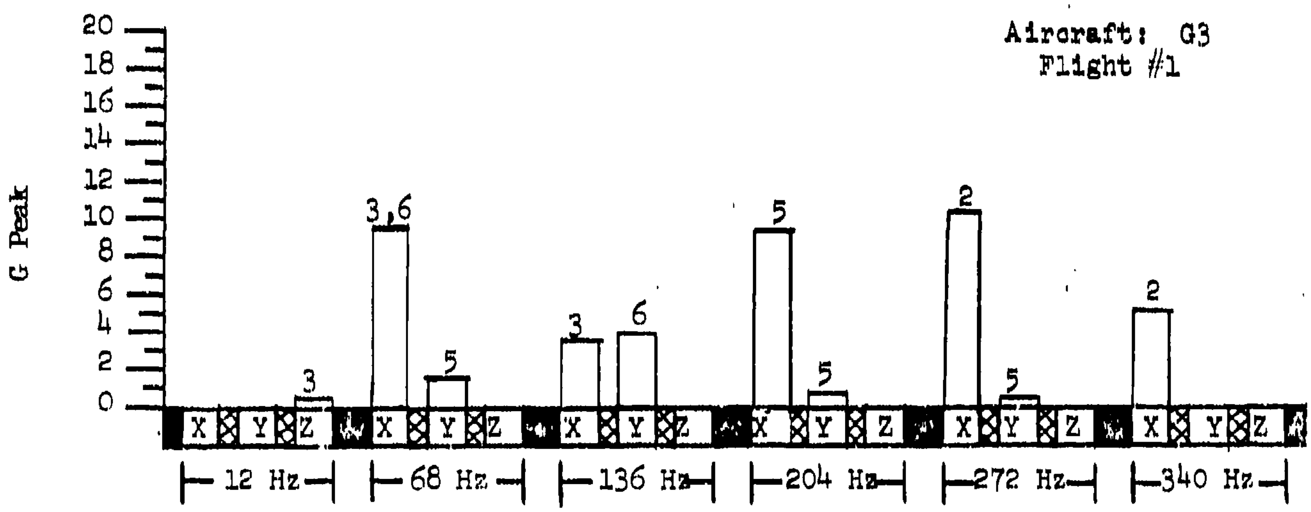


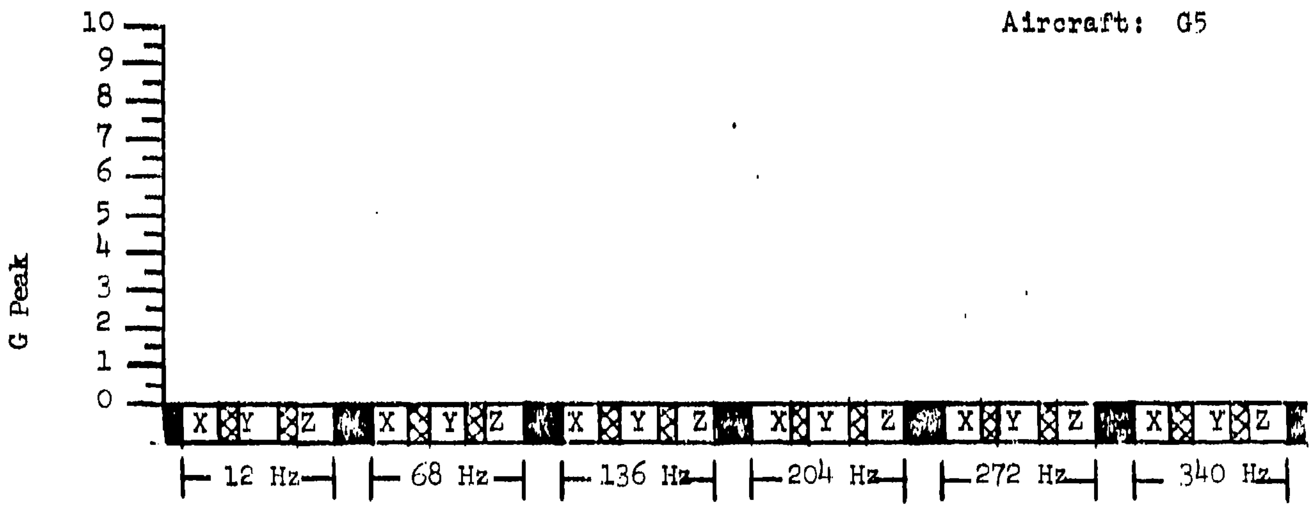




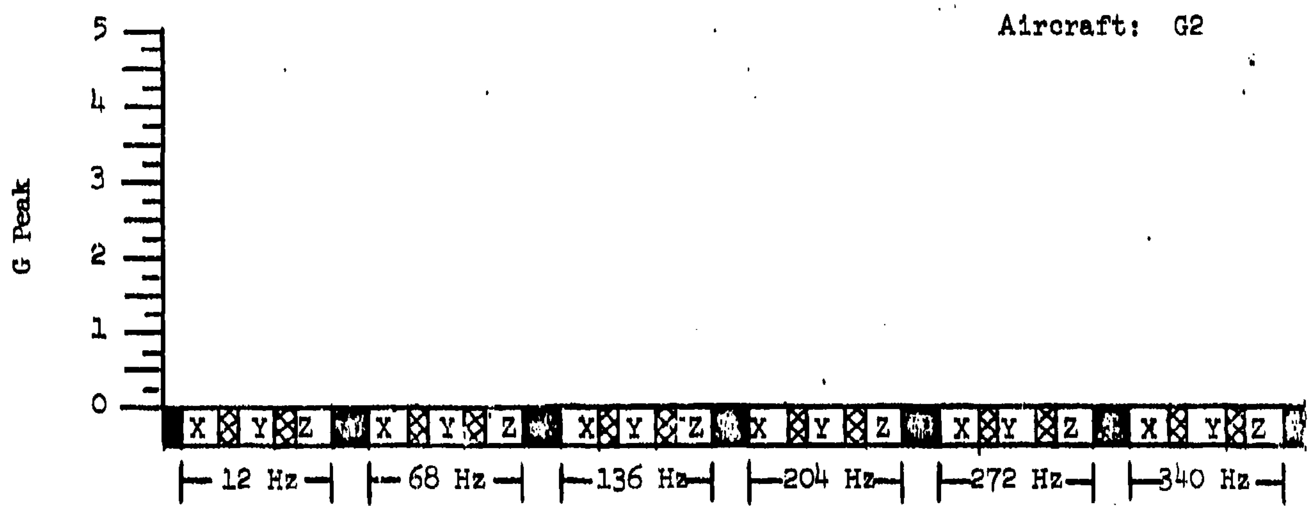
MAXIMUM G RESPONSES
FEEDHORN COUPLER

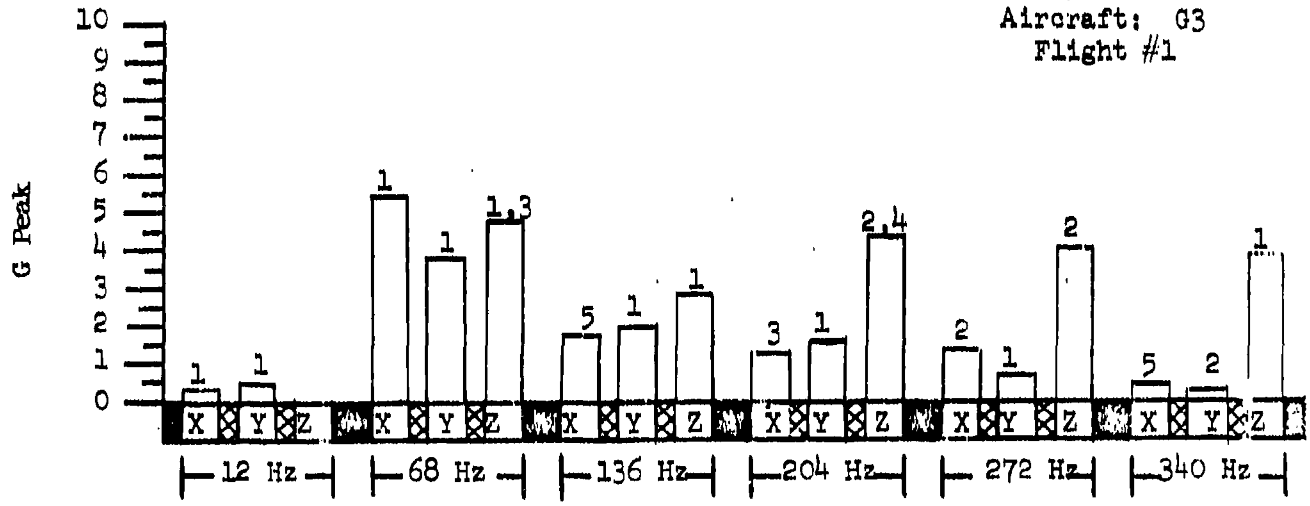


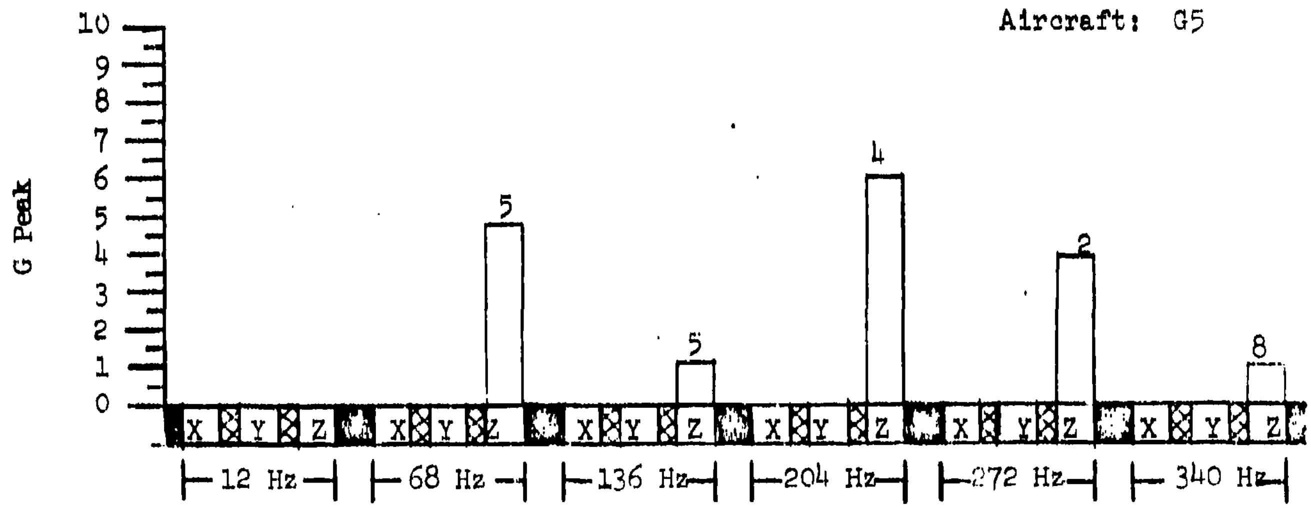




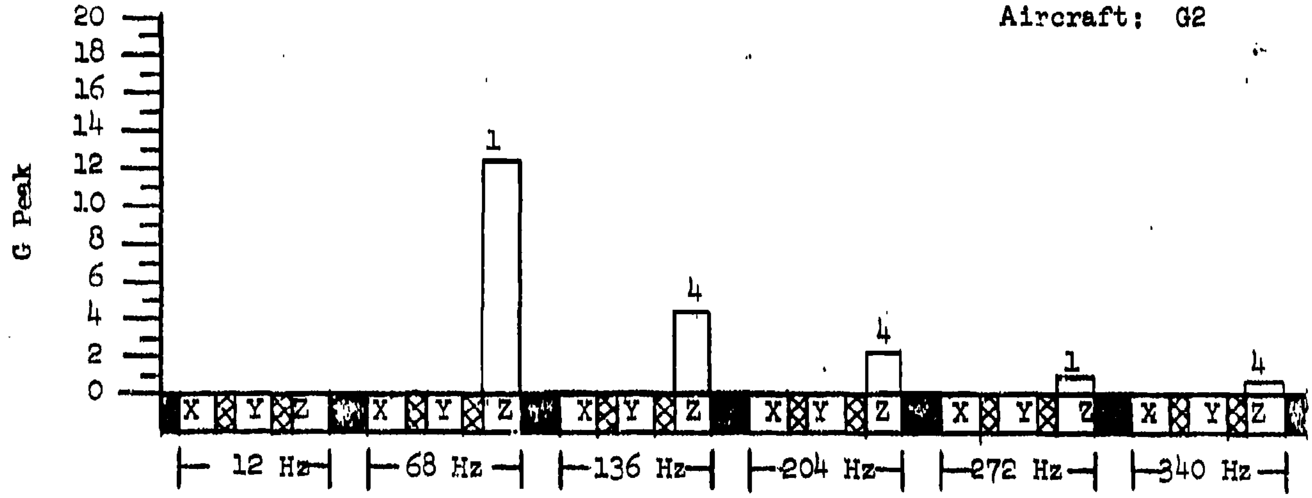
MAXIMUM G RESPONSES
ISOLATION SYSTEM

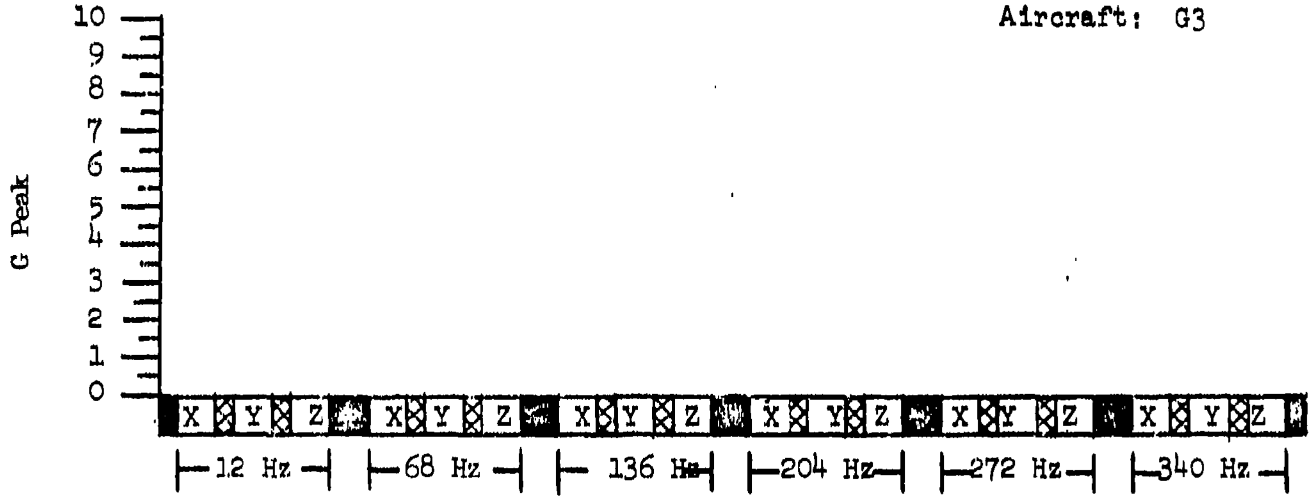


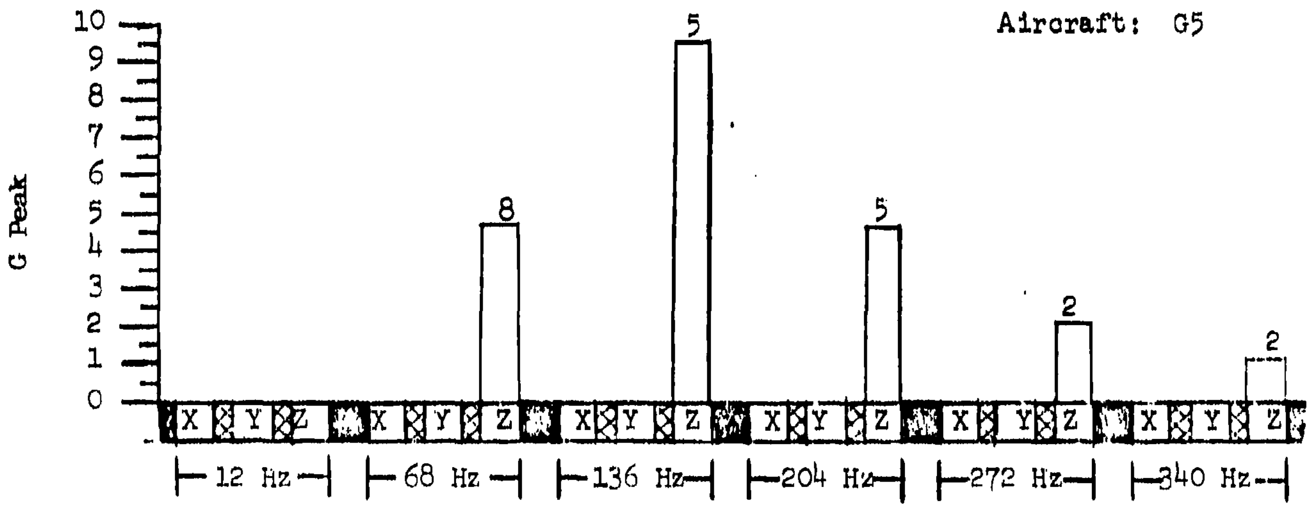




MAXIMUM G RESPONSES
RADOME







APPENDIX E

MAXIMUM SINUSOIDAL RESPONSES

Enclosure (1) - Tables of Maximum Sinusoidal Responses for G2

Enclosure (2) - Tables of Maximum Sinusoidal Responses for G3, Flight No. 1

Enclosure (3) - Tables of Maximum Sinusoidal Responses for G3, Flight No. 2

Enclosure (4) - Tables of Maximum Sinusoidal Responses for G5, Flight No. 2

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G2 (Bureau No. 150497)
Flight No: 1
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Flying 17,800 ft., 220 Kts. IAS, Radome up, Props out of Sync.	.03	12
Pedestal B	Flying 17,800 ft., 220 Kts. IAS, Radome going down, Props in Sync.	1.4	136
TWT (A)	Flying 17,800 ft., 220 Kts. IAS, Radome up, Props in Sync.	1.4	68
TWT B	Flying 17,800 ft., 220 Kts. IAS, Radome up, Props out of Sync.	.03	12

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G2 (Bureau No. 150497)
Flight No: 1
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Flying 17,800 ft., 220 Kts. IAS, Radome being retracted, Props in Sync.	0.5	136
Pedestal (B)	Flying 17,800 ft., 220 Kts. IAS, Radome being retracted, Props in Sync.	0.9	136
TWT (A)	Flying 17,800 ft., 220 Kts. IAS, Radome being retracted, Props in Sync.	3.8	136
TWT (B)	Flying 17,800 ft., 220 Kts. IAS, Radome being retracted, Props in Sync.	1.0	136

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G2 (Bureau No. 150497)
Flight No: 1
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Take off, Pitch applied to Props	1.6	68
Pedestal (B)	Take off, Pitch applied to Props	2.0	68
TWT (A)	Take off, Pitch applied to Props	6.9	68
TWT (B)	Take off, Pitch applied to Props	2.8	68
Radome	Take off, Pitch applied to Props	12.6	68

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 1
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Take off, Pitch applied to Props	1.5	68
Feedhorn Assembly	Flying 17,800 ft., 190 Kts. IAS, Radome down, Props out of Sync.	0.6	20
Feedhorn Coupler	Flying 18,000 ft., 185 Kts. IAS, Radome up, Props in Sync.	10.5	272
Isolation System	Take off, Pitch applied to Props	5.4	68

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 1
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Flying 18,000 ft., 190 Kts. IAS, Radome down, Props in Sync.	0.03	68
Feedhorn Assembly	Take off, Pitch applied to Props	0.4	68
Feedhorn Coupler	Flying 18,000 ft., 190 Kts. IAS, Radome down, Props out of Sync.	4.3	136
Isolation System	Take off, Pitch applied to Props	3.7	68

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 1
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Take off, Pitch applied to Props	1.6	136
Feedhorn Assembly	Take off, Pitch applied to Props	4.3	68
Feedhorn Coupler	Flying 18,000 ft., 230 Kts. IAS, Radome up, Props in Sync.	0.2	12
Isolation System	Take off, Pitch applied to Props and Flying 18,000 ft., 230 Kts. IAS, Radome up, Props out of Sync.	4.7	68

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 2
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Landing, Reverse Pitch applied to Props	0.3	68
Pedestal (B)	Landing, Reverse Pitch applied to Props	0.7	136
TWT (A)	Take off, Pitch applied to Props	0.6	68
TWT (B)	Take off, Pitch applied to Props	0.6	68

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 2
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	--	--	--
Pedestal (B)	Take off, Pitch applied to Props	1.1	136
TWT (A)	Take off, Pitch applied to Props	1.2	136
TWT (B)	Take off, Pitch applied to Props	0.6	136

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 2
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (A)	Flying 2000 ft., 173 Kts. IAS, Radome going down, Props in Sync., Take off, Pitch applied to Props	0.7 (0.1 in. D.A. Displ.) 1.6	12 68
Pedestal (B)	Take off, Pitch applied to Props	1.8	68
TWT (A)	--	--	--
TWT (B)	Take off, Pitch applied to Props	1.4	68

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G5 (Bureau No. 150502)
Flight No: 2
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (B)	Flying 19,000 ft., 220 Kts. IAS, Radome down*	2.0	136
Feedhorn Assembly	Taxiing, Radome up*	0.9	12
TWT (A)	Flying 17,000 ft., 228 Kts. IAS, Radome down*	0.8	136

*Flight conditions of props in and out of sync. were not used during Flight Tests for G5.

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G5 (Bureau No. 150502)
Flight No: 2
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Feedhorn Assembly	Take off, Pitch applied to Props	1.7	136
TWT (A)	Flying 17,000 ft., 228 Kts. IAS, Radome down*	8.0	136

*Flight conditions of props in and out of sync. were not used during Flight Tests for G5.

TABLE OF MAXIMUM SINOSOIDAL RESPONSES

Plane No: G5 (Bureau No. 150502)
Flight No: 2
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Sinusoidal Response (pk g)	Frequency (Hz)
Pedestal (B)	Flying 19,000 ft., 220 Kts. IAS, Radome down*	0.5	272
Feedhorn Assembly	Take off, Pitch applied to Props	2.7	68
TWT (A)	Flying 17,000 ft., 228 Kts. IAS, Radome down*	0.7	136
Isolation System	Flying 21,000 ft., 245 Kts. IAS, Radome descending*	6.0	204
Radome	Flying 21,000 ft., 245 Kts. IAS, Radome down*	9.7	136

*Flight conditions of props in and out of sync. were not used during Flight Tests for G5.

APPENDIX F

FILTERED TIME HISTORY CURVES

Enclosure (1) - FILTERED PEAK TIME HISTORY FOR G2

Enclosure (2) - FILTERED PEAK TIME HISTORY FOR G3, FLIGHT NO. 1

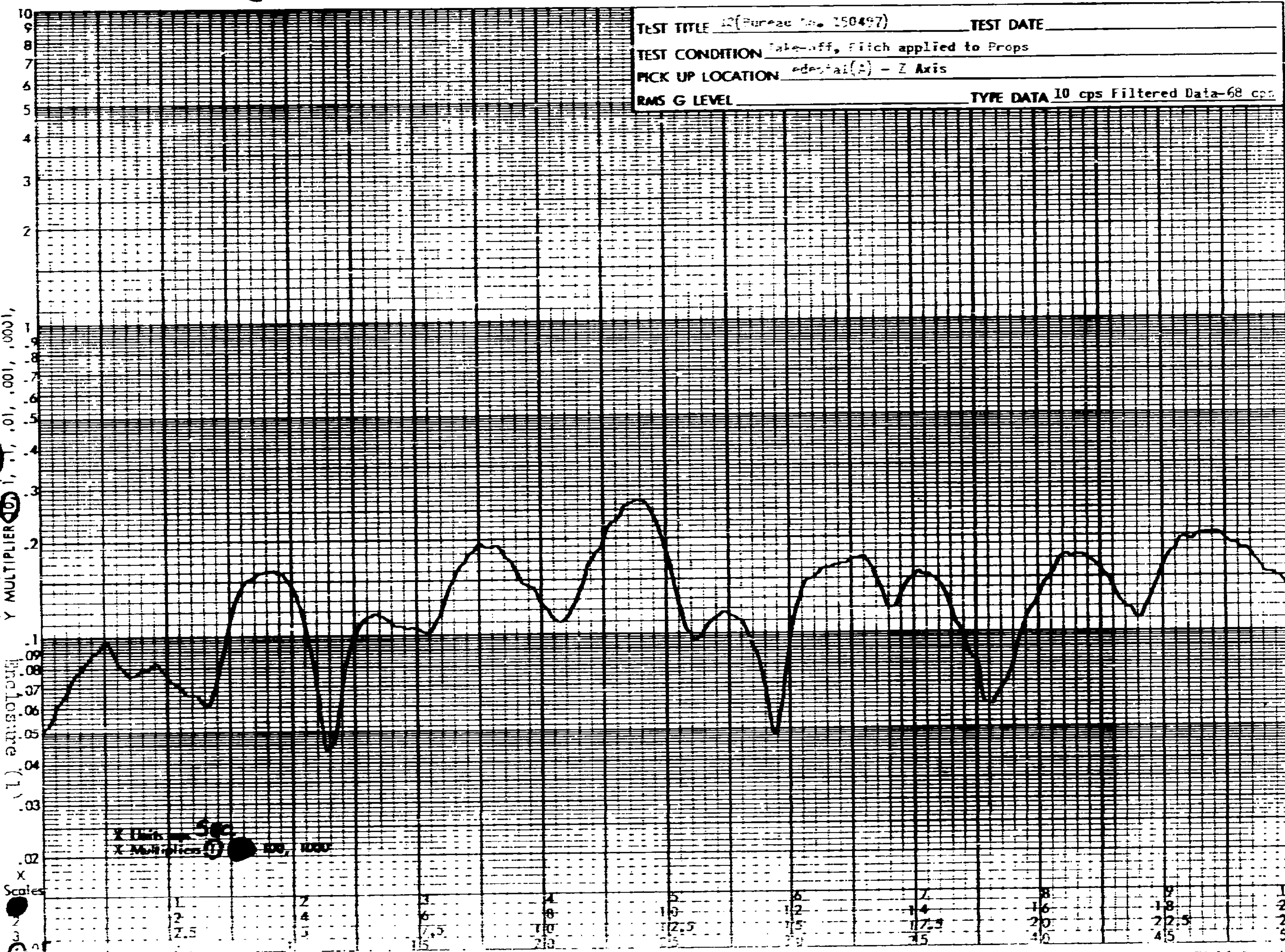
Enclosure (3) - FILTERED PEAK TIME HISTORY FOR G3, FLIGHT NO. 2

TEST TITLE 12(Bureau No. 150497) TEST DATE

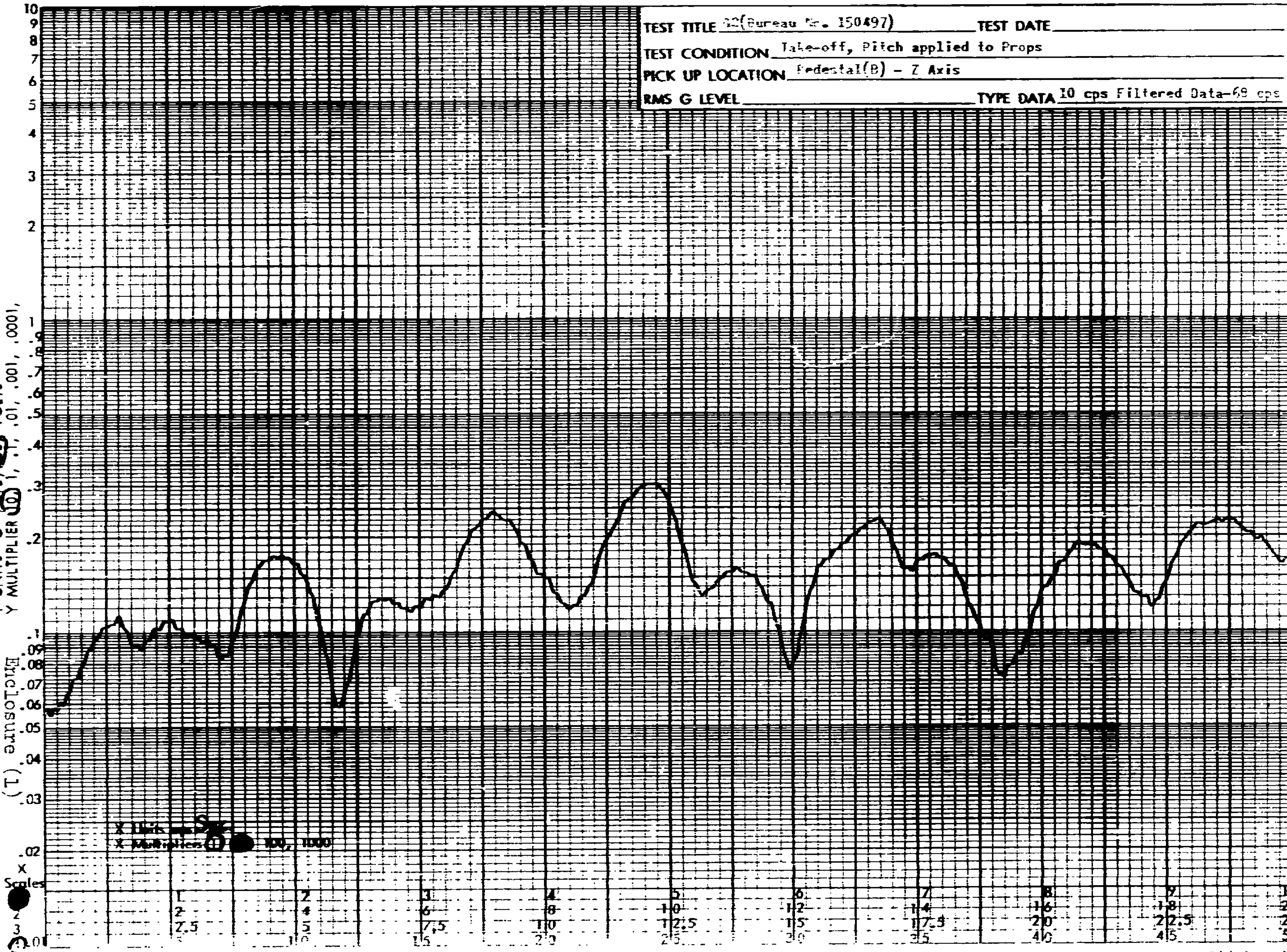
TEST CONDITION Take-off, Pitch applied to Props

PICK UP LOCATION Pedestal(A) - Z Axis

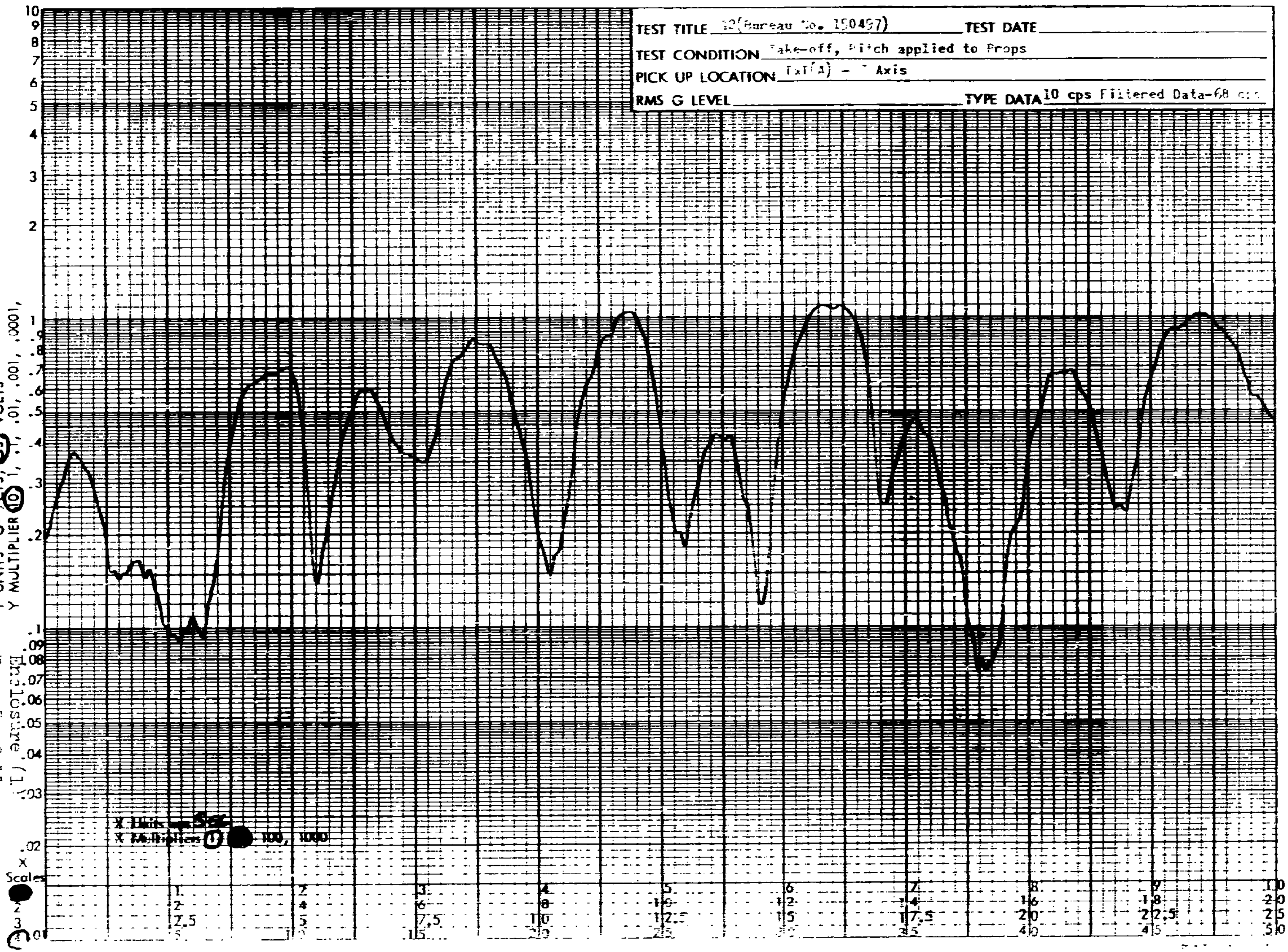
RMS G LEVEL TYPE DATA 10 cps Filtered Data-68 cps



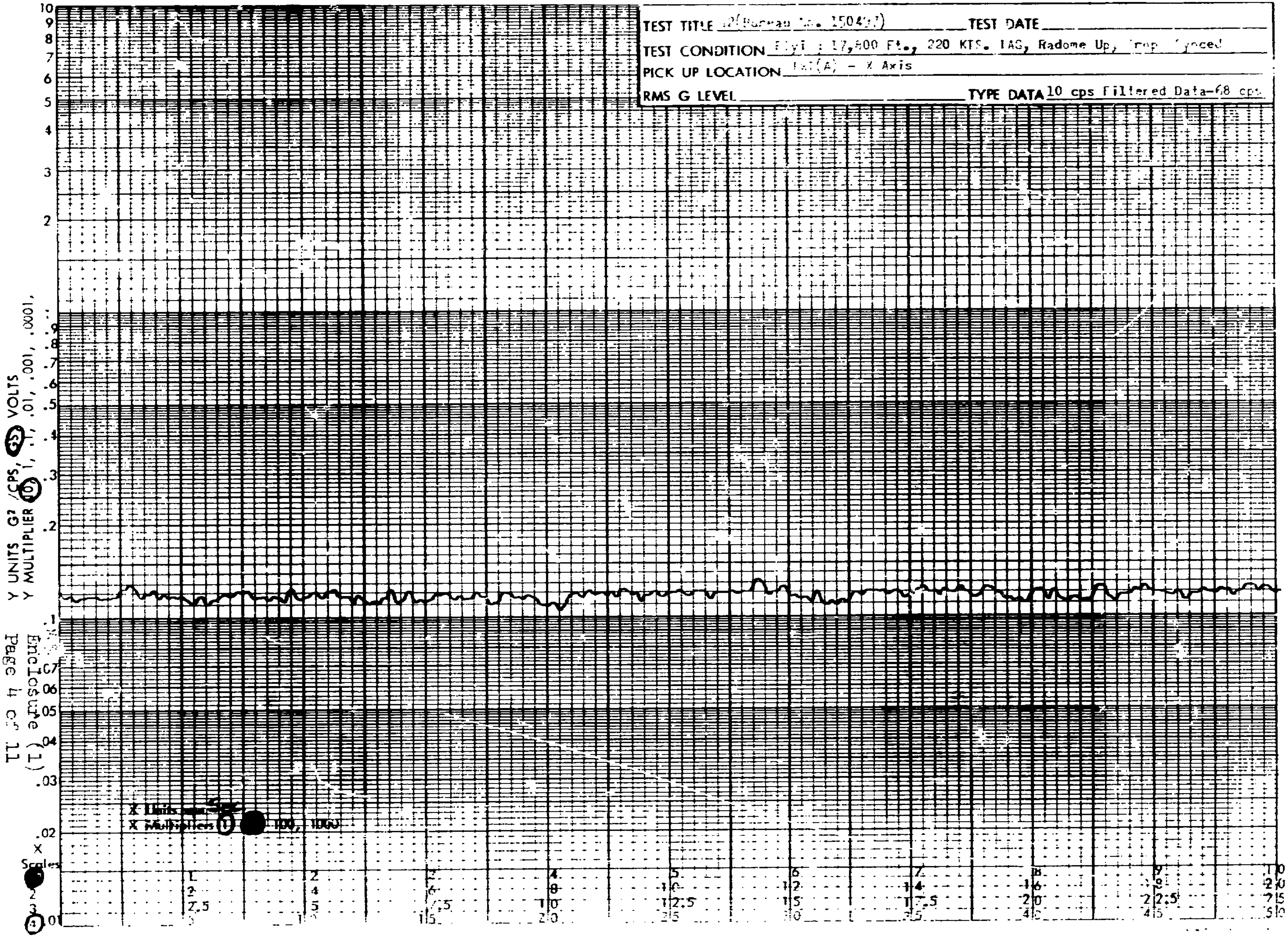
Enclosure (1)
Page 1 of 11



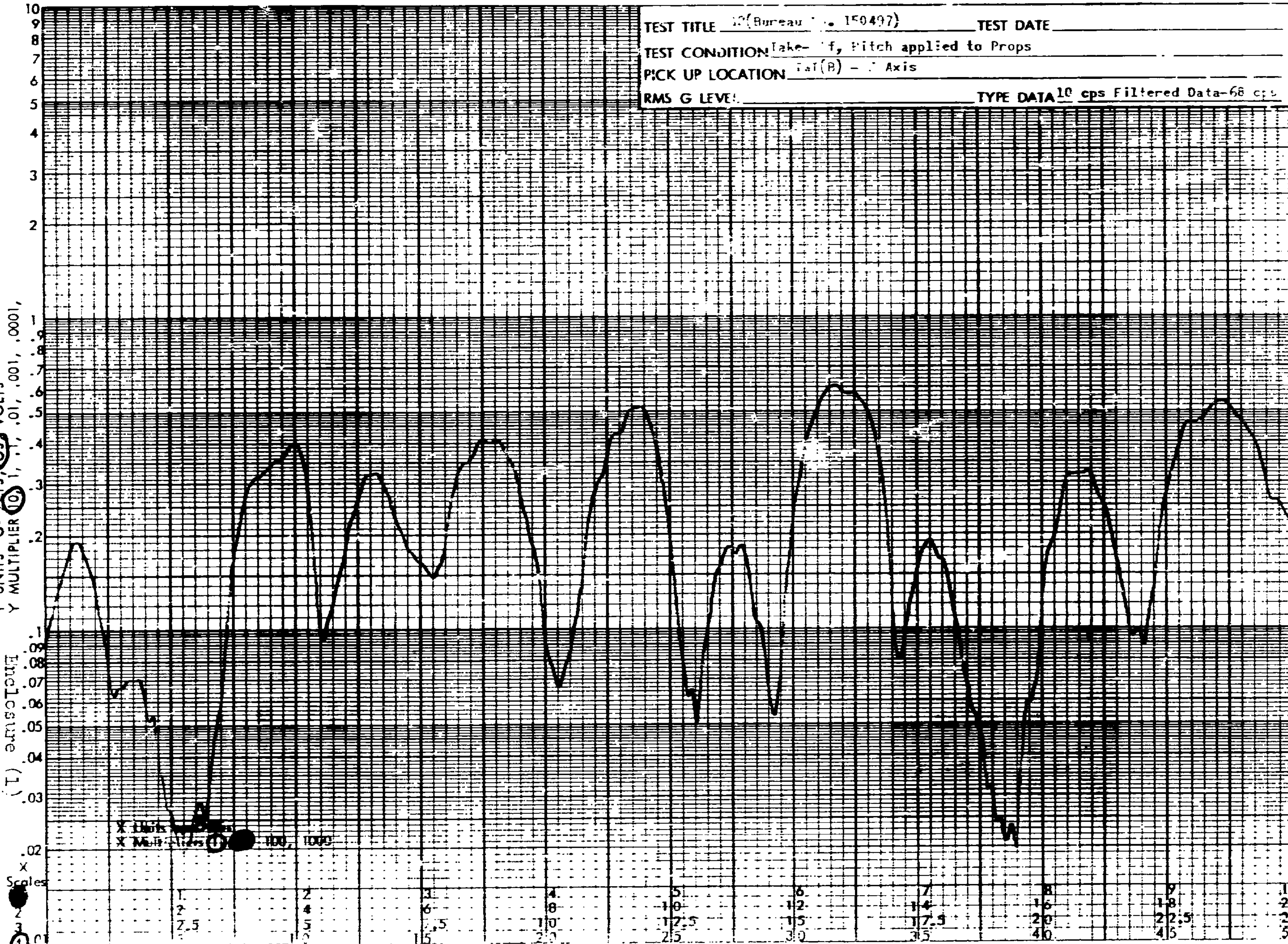
Enclosure (1)
Page 2 of 11

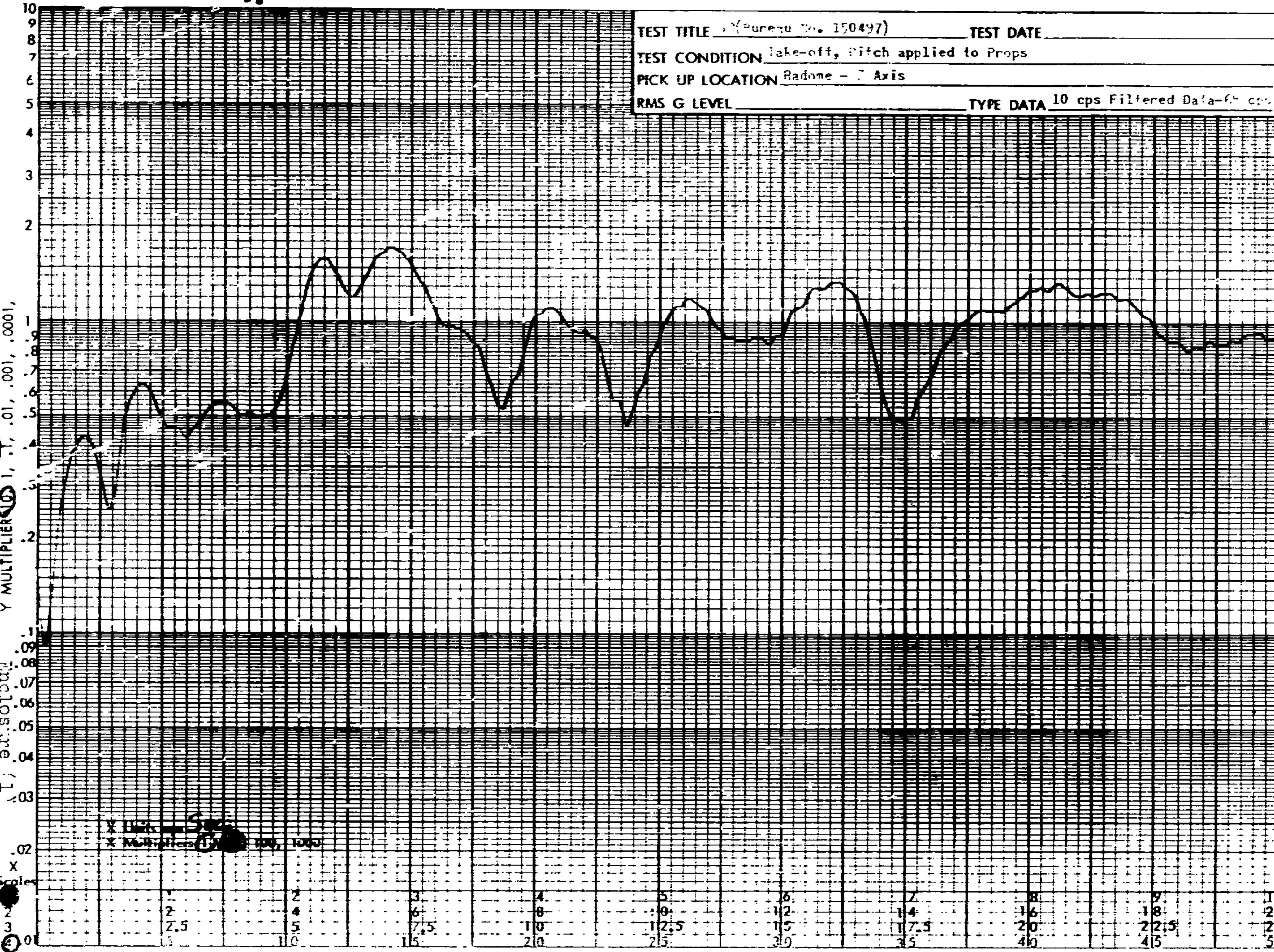


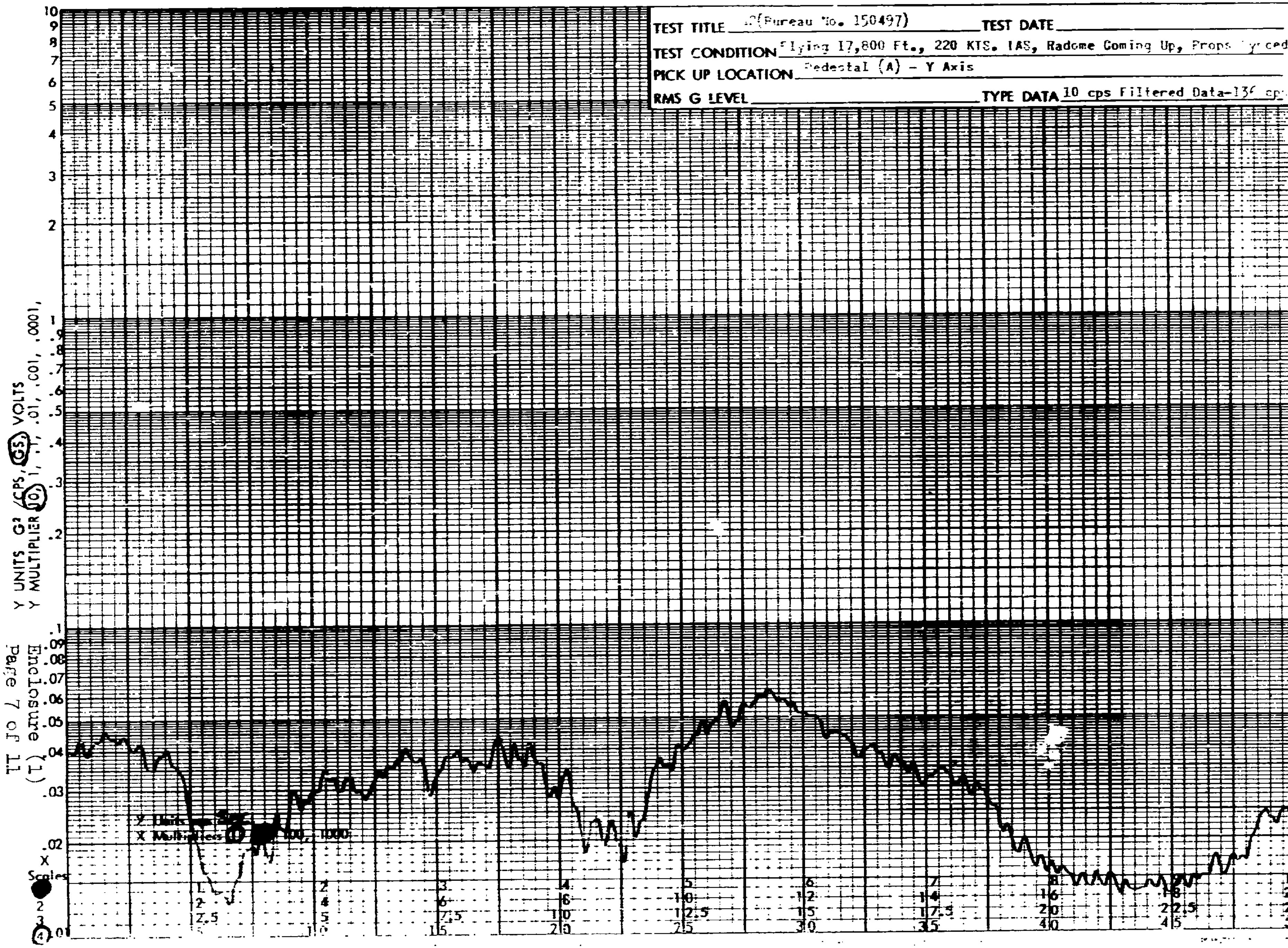
Enclosure (1)
Page 3 of 11



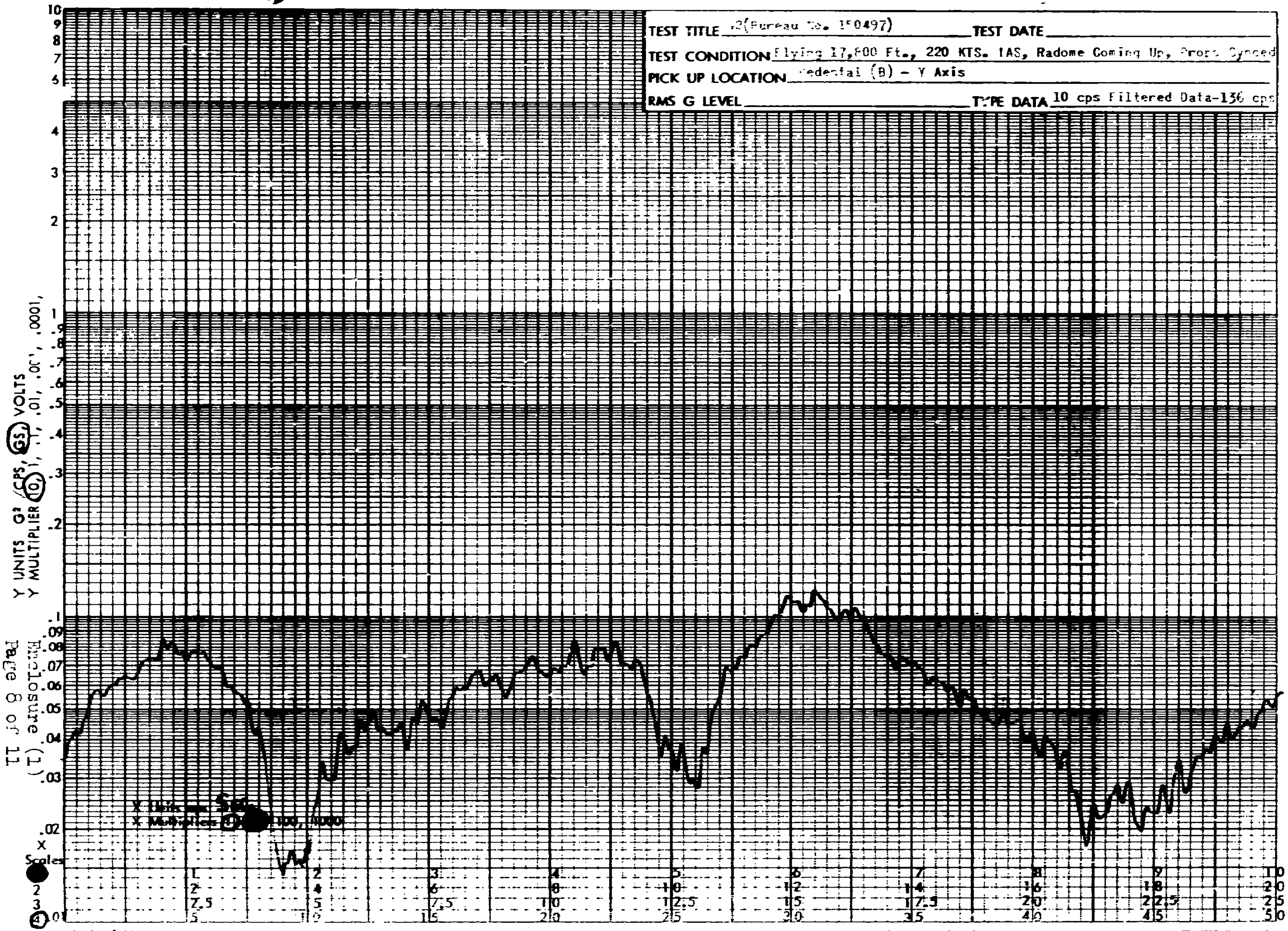
Enclosure (1)
Page 4 of 11


TEST TITLE ?(Bureau . 150497)
TEST DATE
TEST CONDITION Take- f, Pitch applied to Props
PICK UP LOCATION T&T(B) - Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001,
X Units
X Multipliers 1, 100, 1000
X Scales

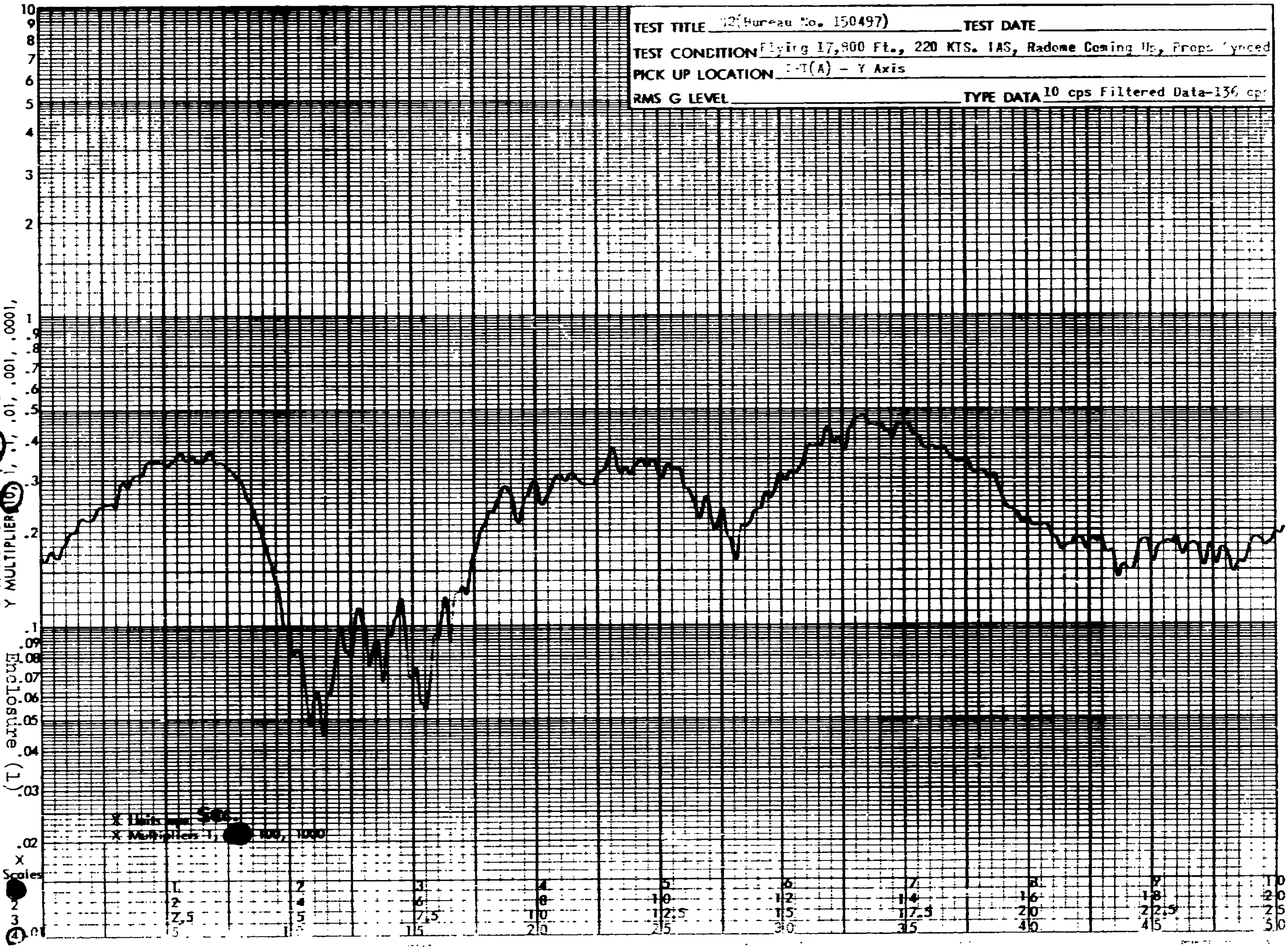

TEST TITLE (Bureau No. 150497)
TEST DATE
TEST CONDITION Take-off, Pitch applied to Props
PICK UP LOCATION Radome - Z Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-6 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units Secs
X Multiplier 1, 10, 100, 1000
X Scales


TEST TITLE ?(Bureau No. 150497) TEST DATE
TEST CONDITION Flying 17,800 Ft., 220 KTS. IAS, Radome Coming Up, Props Syncd
PICK UP LOCATION Pedestal (A) - Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-13 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001,
Y Units
X Multipliers 10, 100, 1000
X Scales

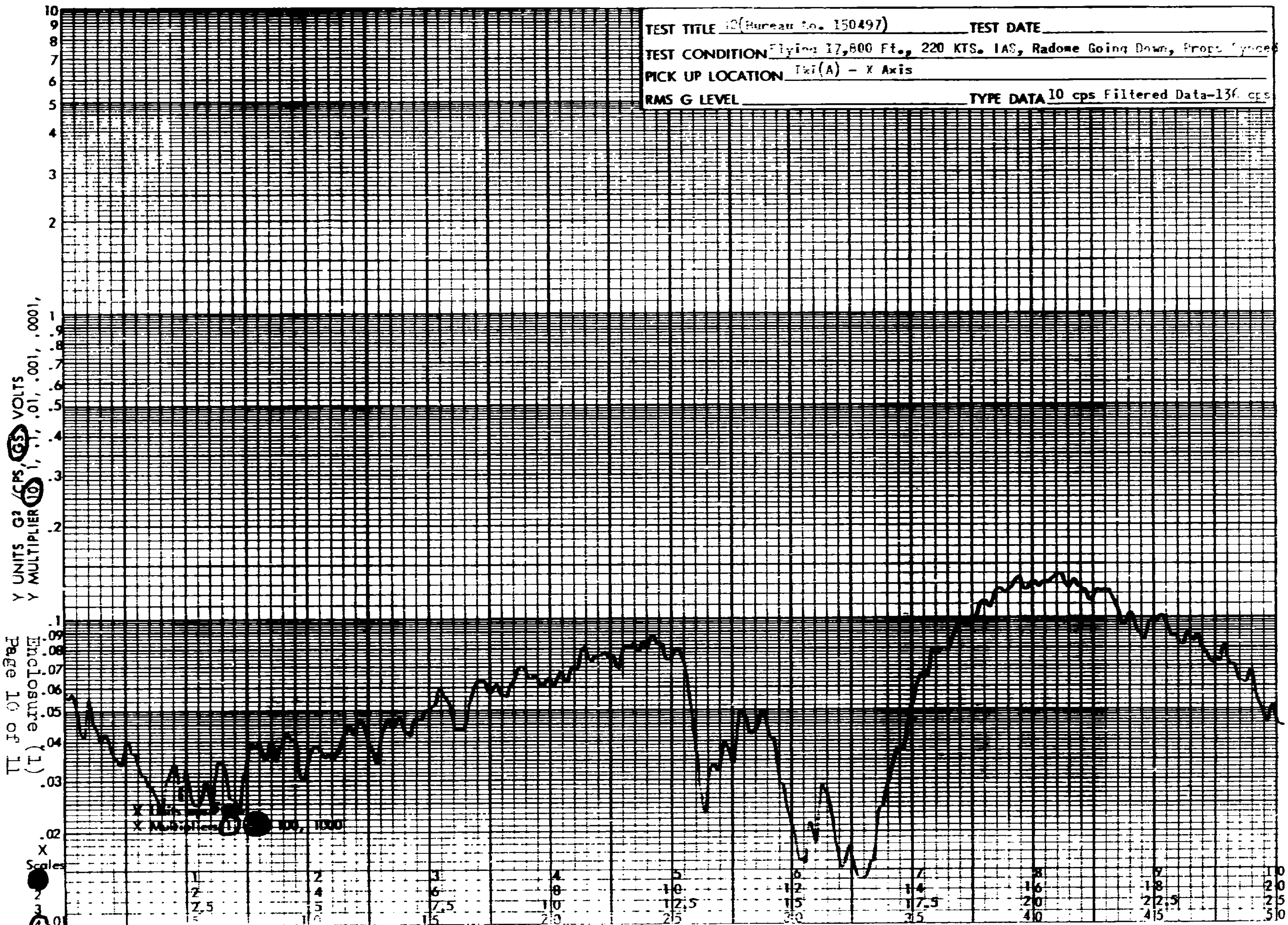
Enclosure (1)



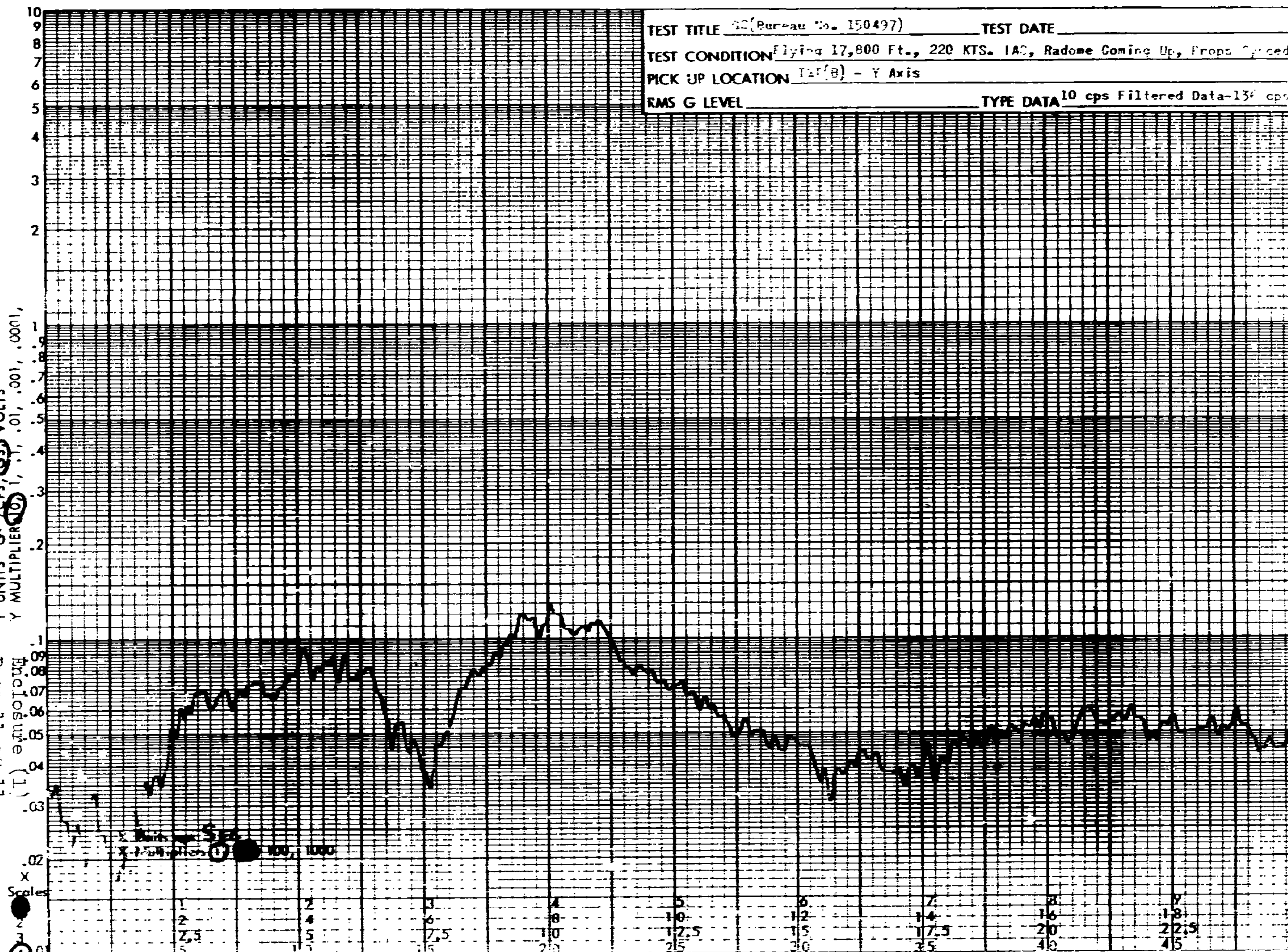
Enclosure (1)
Page 8 of 11

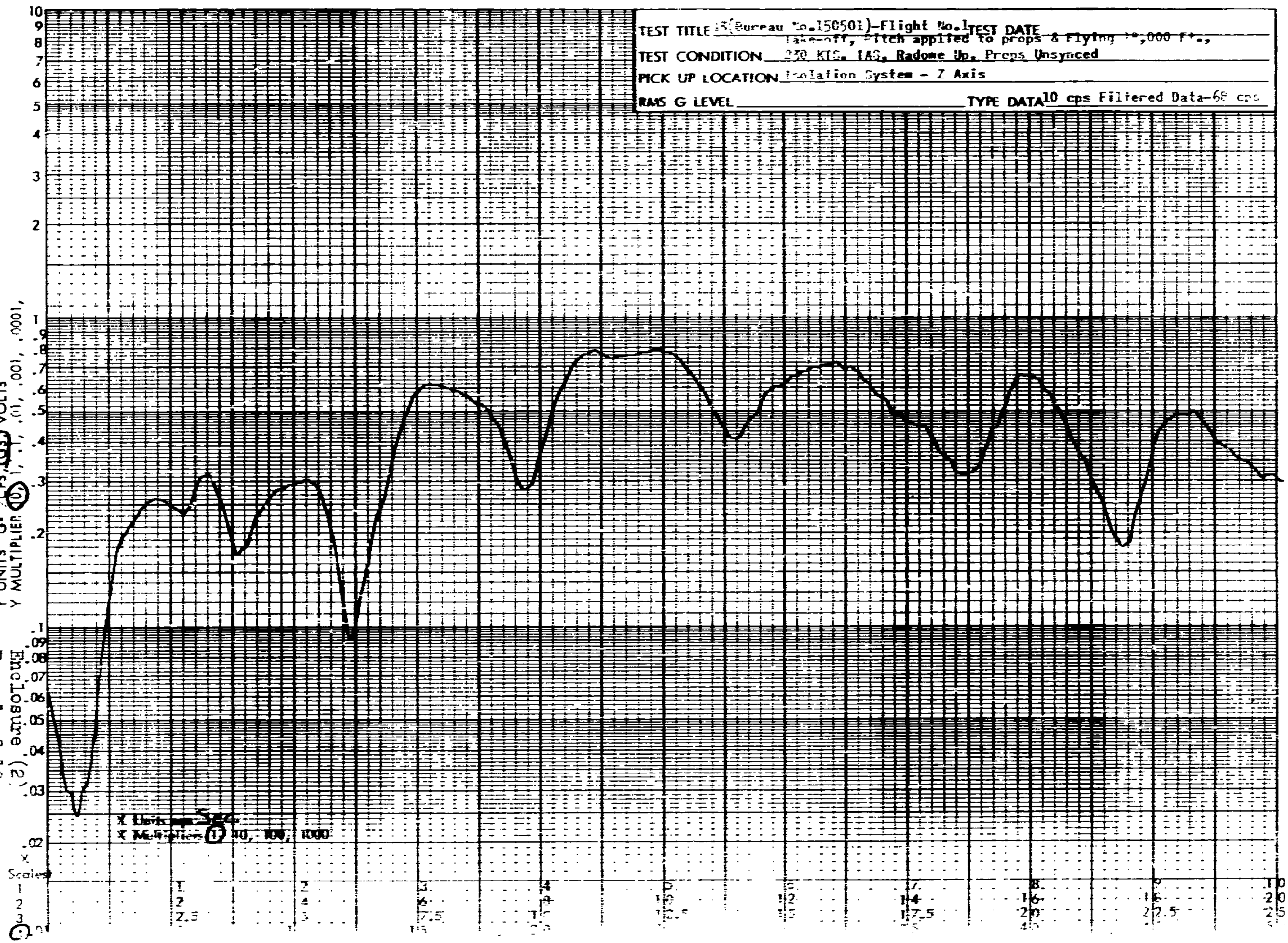


TEST TITLE 32(Bureau No. 150497)
TEST DATE
TEST CONDITION Flying 17,900 Ft., 220 KTS. IAS, Radome Coming Up, Props Synced
PICK UP LOCATION I-T(A) - Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-136 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001,
X Units Sec.
X Multiplier 1, 10, 100, 1000
X Scales

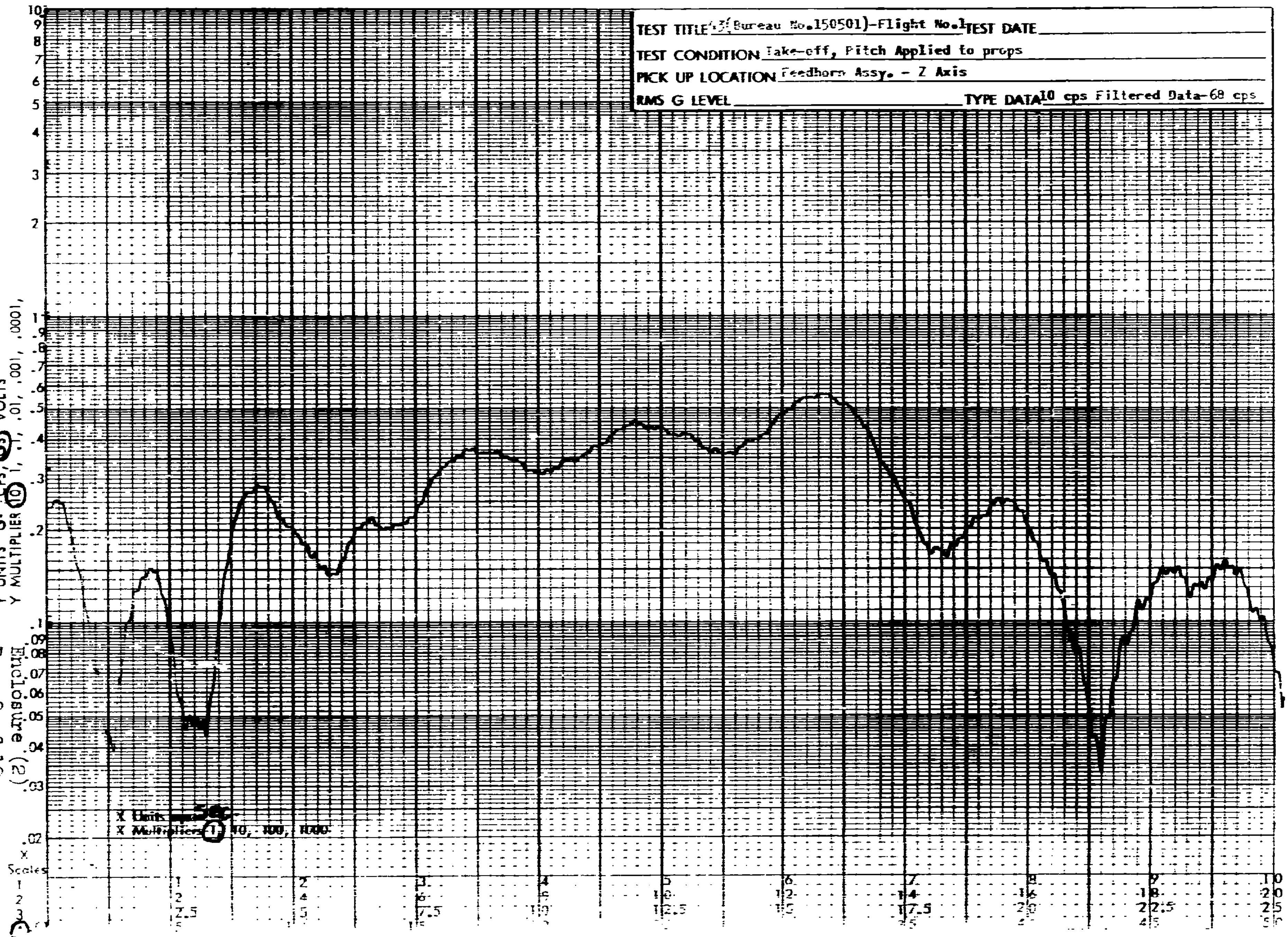


Enclosure (1)
Page 10 of 11


TEST TITLE ?(Bureau No. 150497)
TEST DATE
TEST CONDITION Flying 17,800 Ft., 220 KTS. IAS, Radome Coming Up, Props Synced
PICK UP LOCATION T?(B) - Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-13? cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units
X Multiplier 1, 100, 1000
X Scales



Enclosure (2)
Page 1 of 10

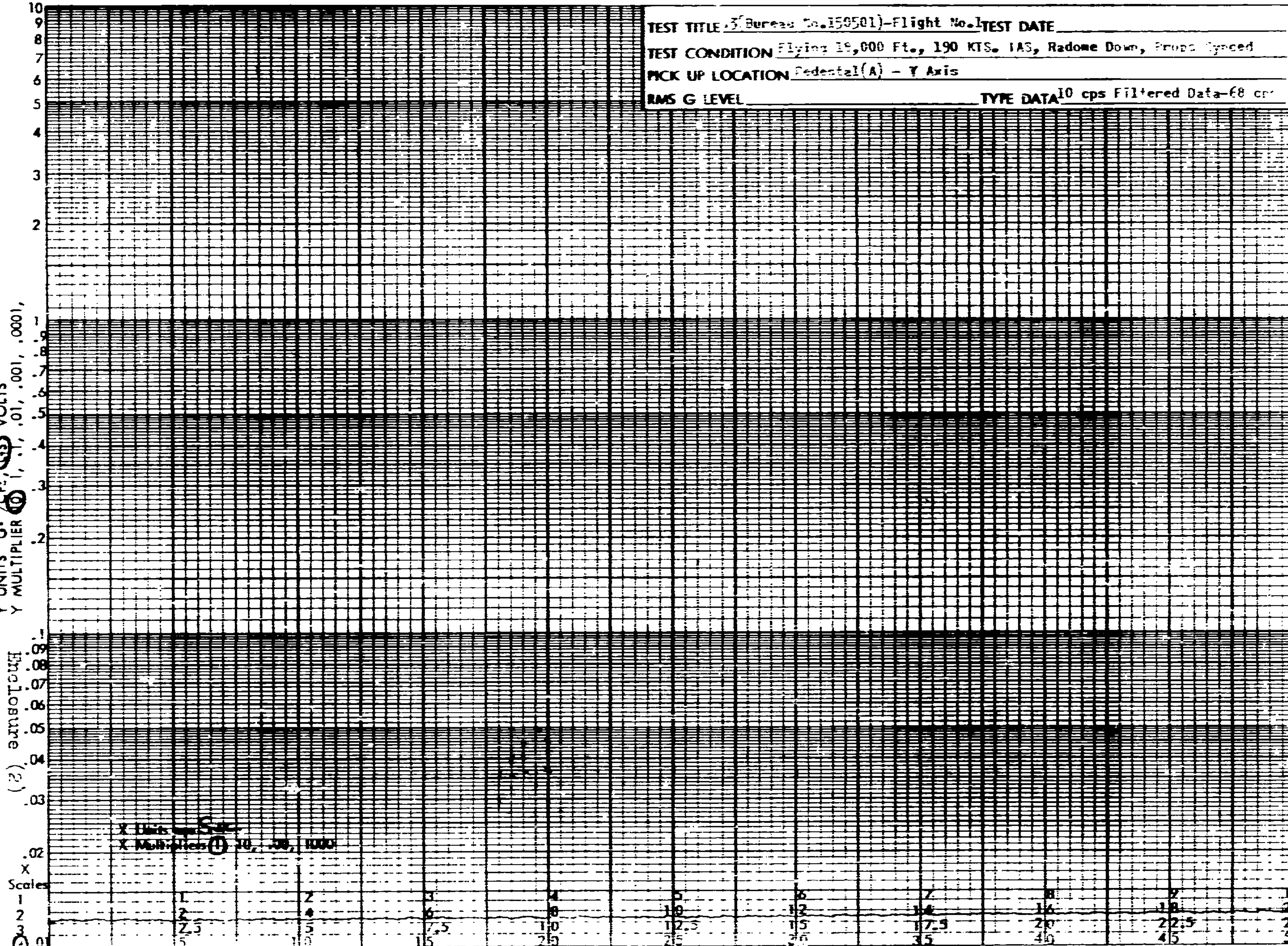

TEST TITLE 43 (Bureau No.150501)-Flight No.1 TEST DATE
TEST CONDITION Take-off, Pitch Applied to props
PICK UP LOCATION Feedhorn Assy. - Z Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G² /CPS, G5 VOLTS
Y MULTIPLIER 10 1, .1, .01, .001, .0001
X Units Sec
X Multipliers 1, 10, 100, 1000
X Scales

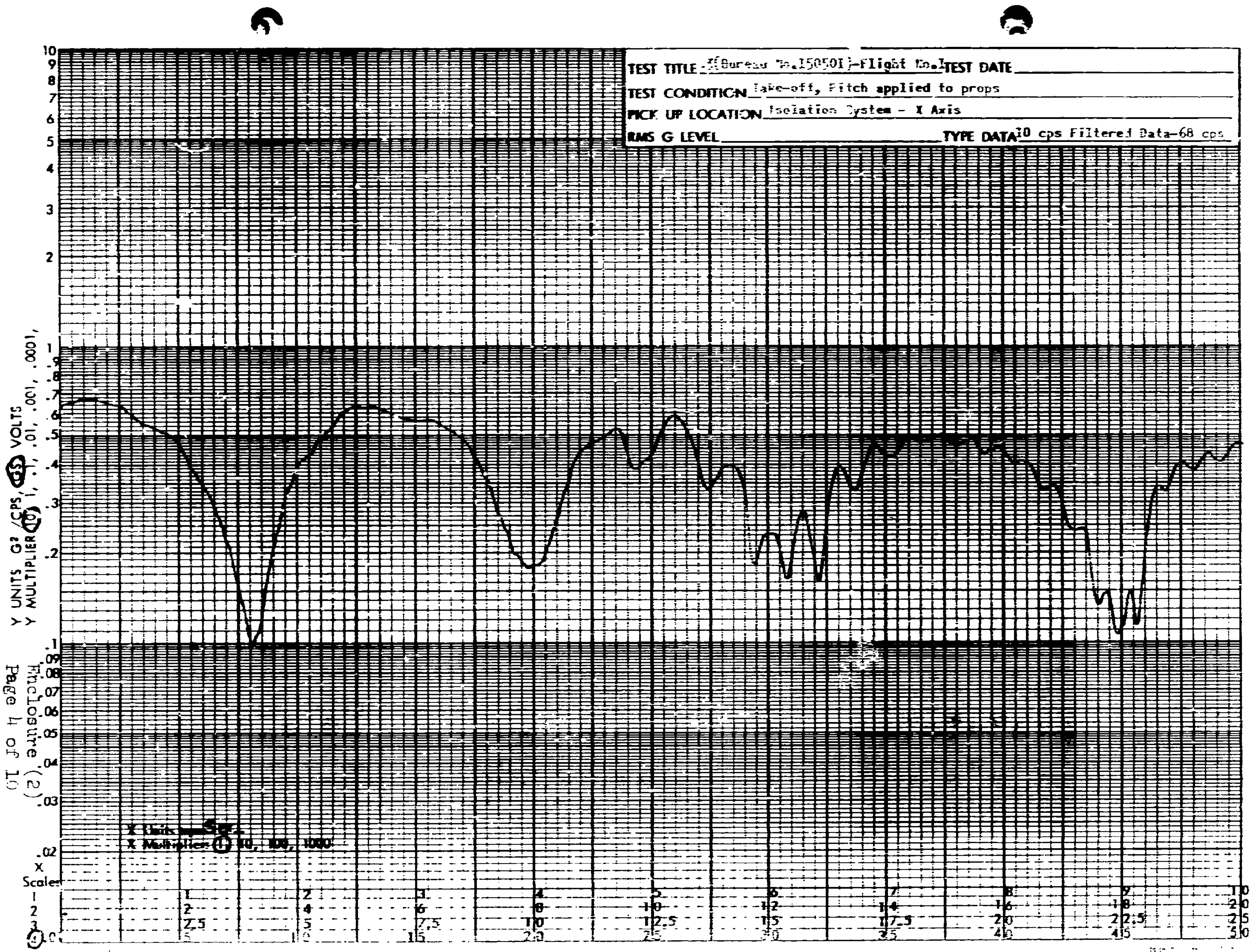
TEST TITLE .3 (Bureau No.150501)-Flight No.1 TEST DATE

TEST CONDITION Flying 19,000 Ft., 190 KTS. IAS, Radome Down, Props Synced

PICK UP LOCATION Pedestal(A) - Y Axis

RMS G LEVEL ______ TYPE DATA 10 cps Filtered Data-68 cps





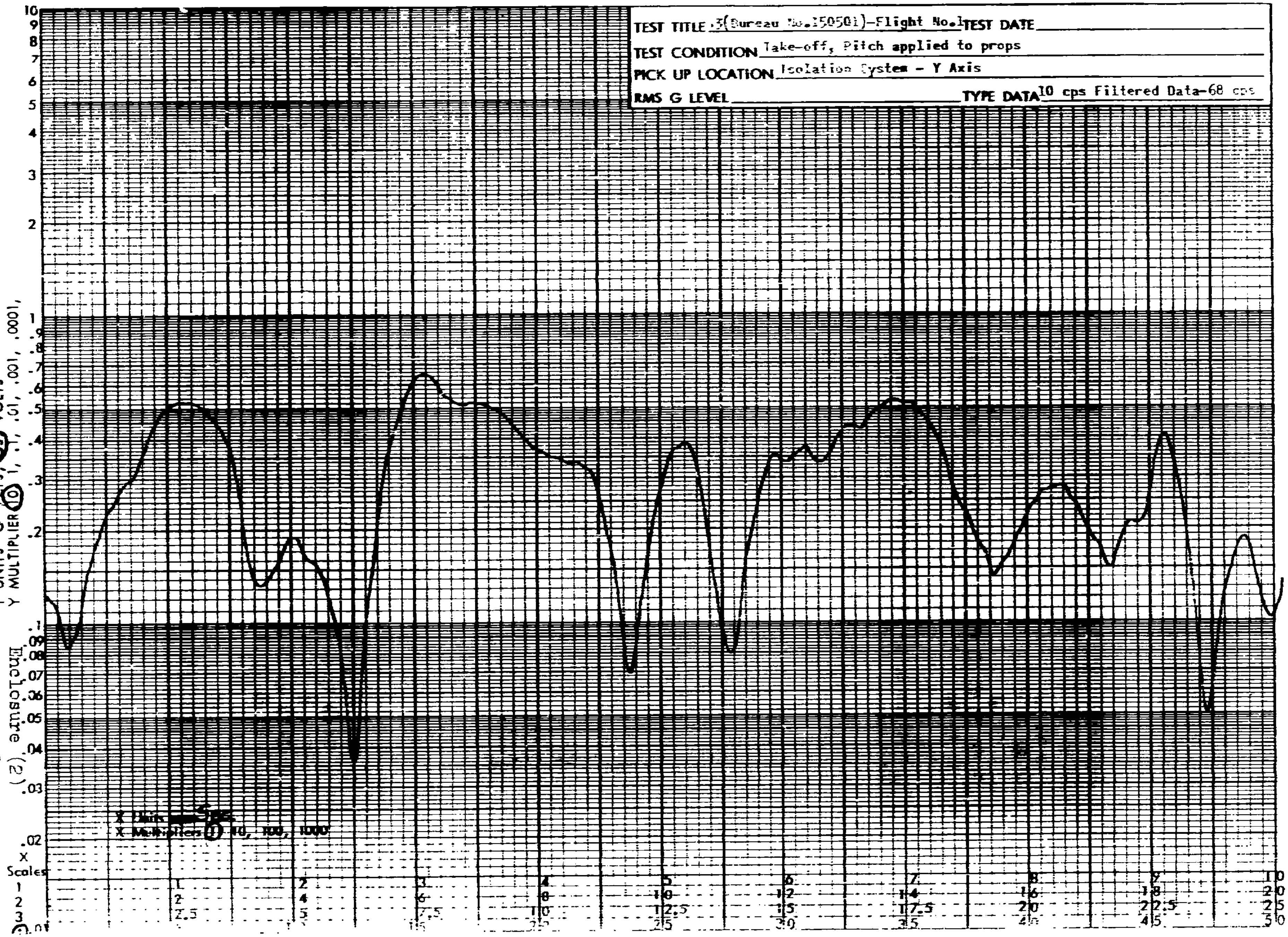
Enclosure (2)
Page 4 of 10

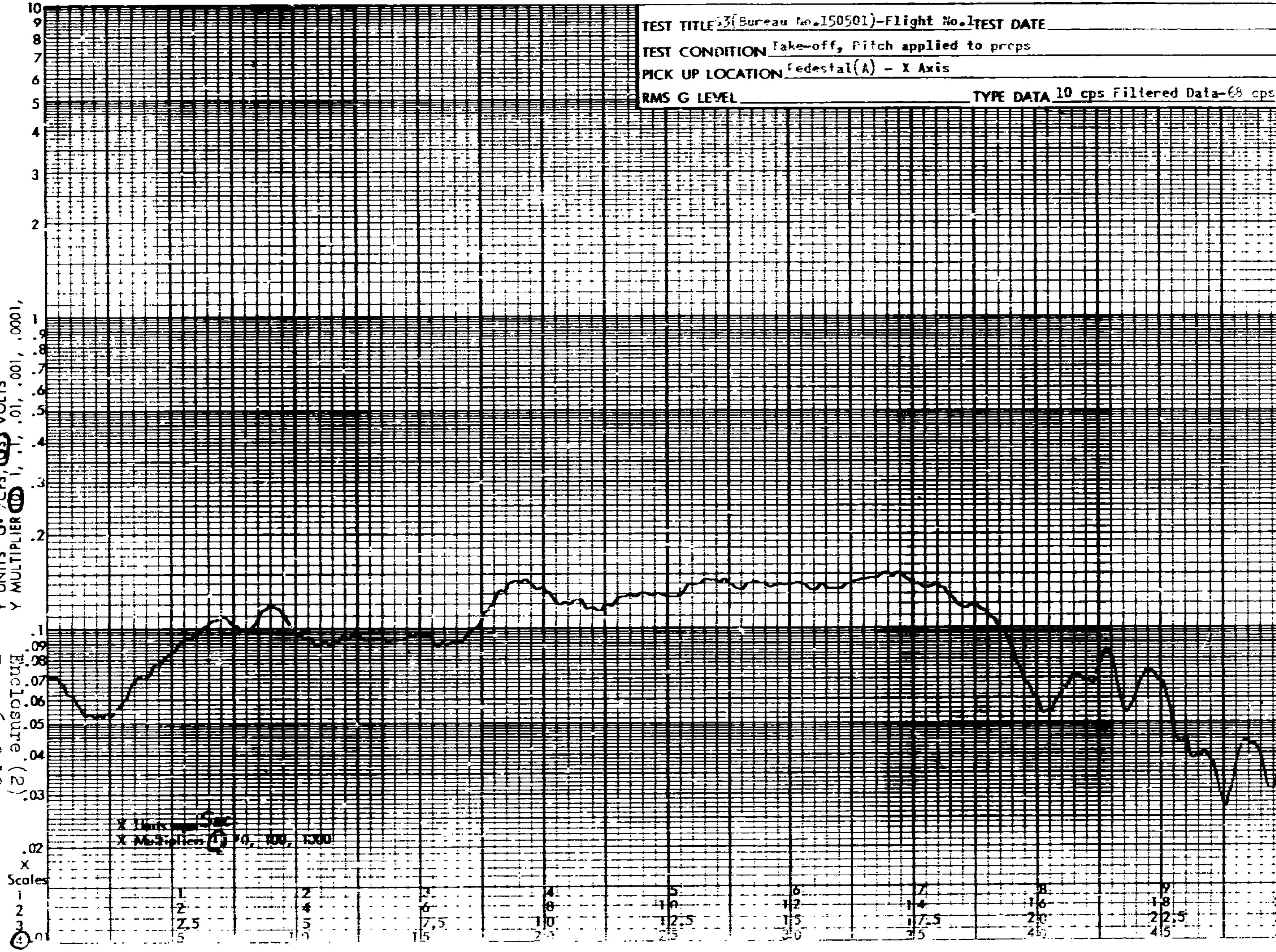
TEST TITLE .3(Bureau No.150501)-Flight No.1 TEST DATE

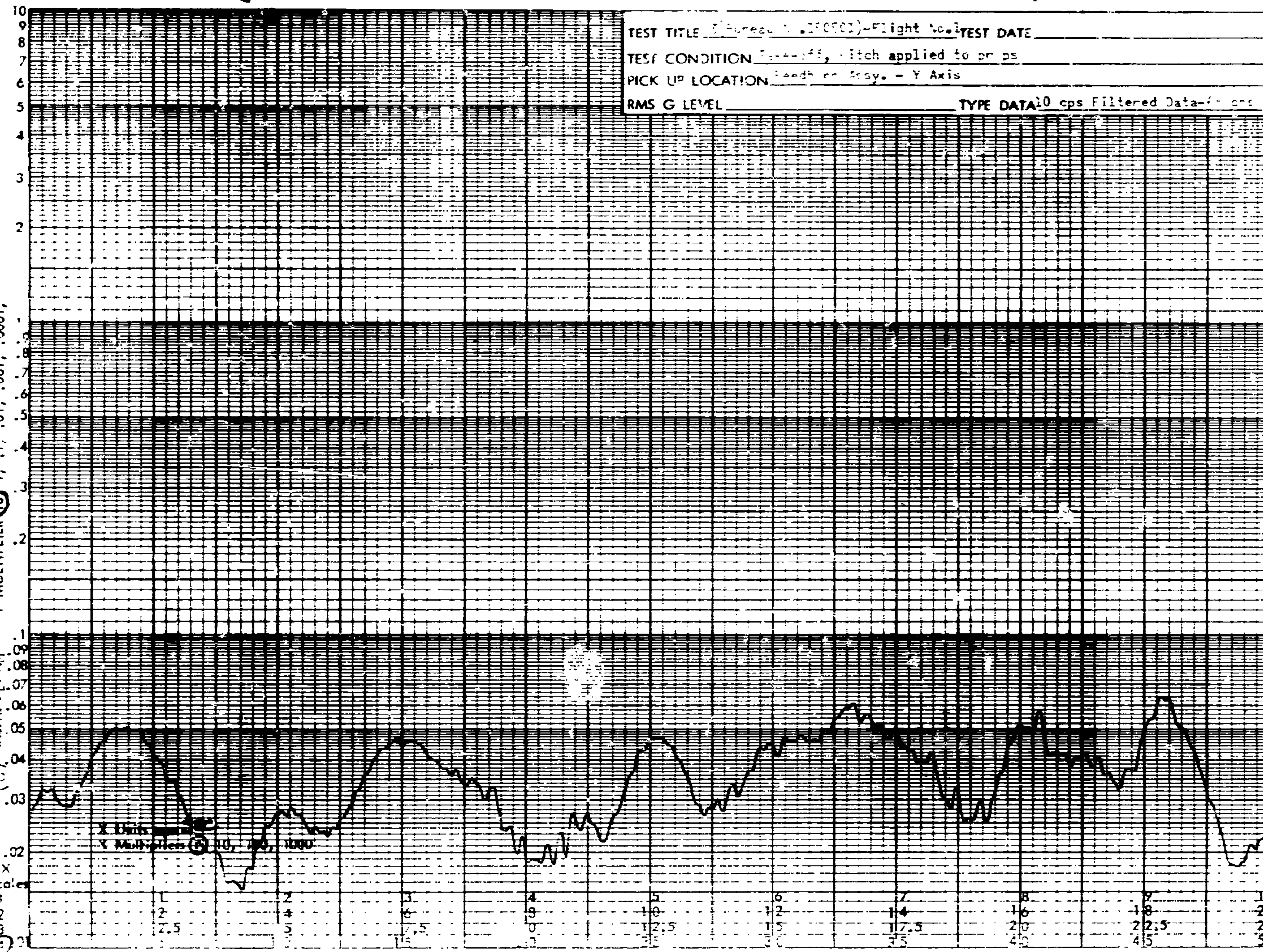
TEST CONDITION Take-off, Pitch applied to props

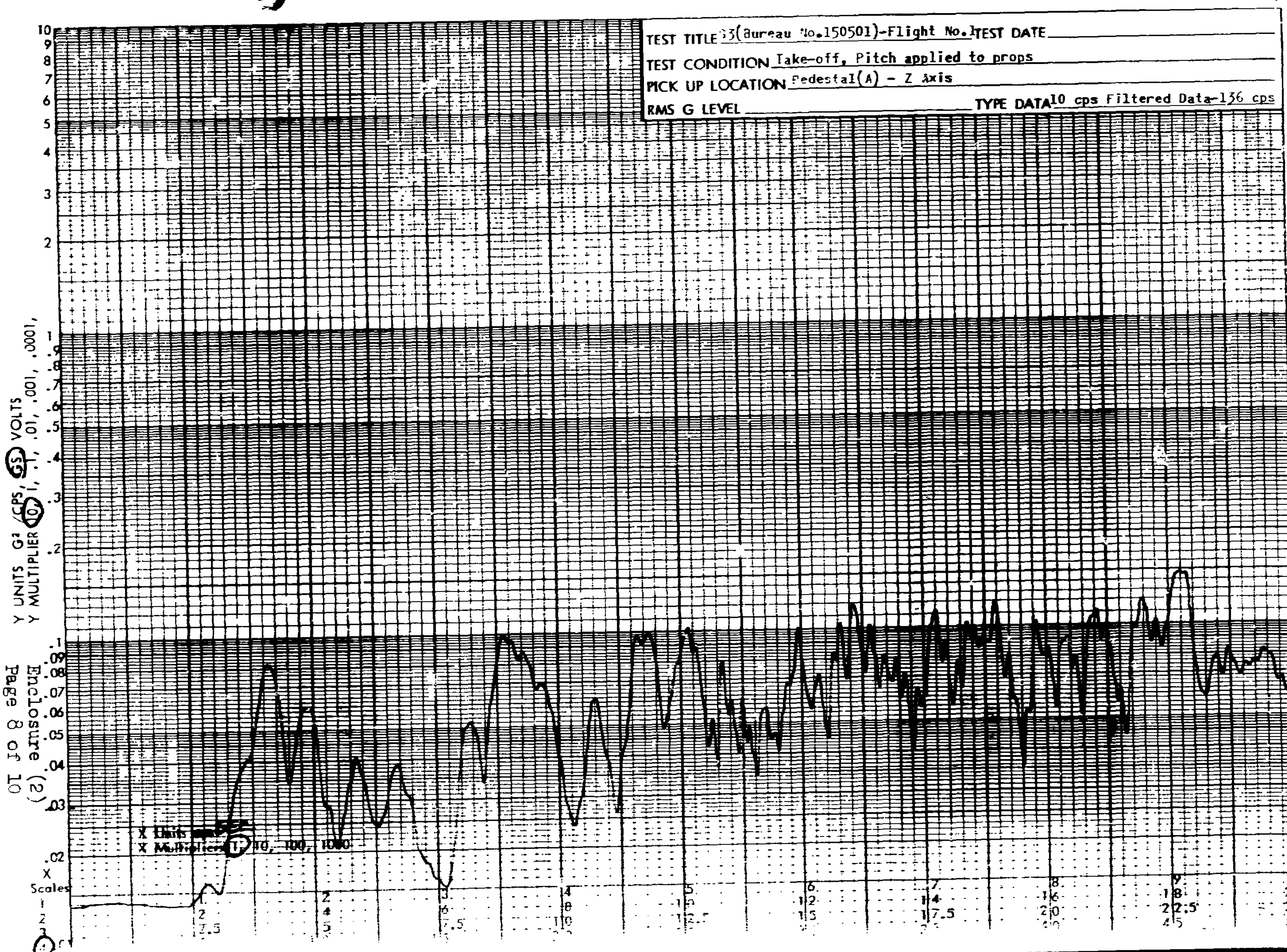
PICK UP LOCATION Isolation System - Y Axis

RMS G LEVEL ____ TYPE DATA 10 cps Filtered Data-68 cps




TEST TITLE 53(Bureau No.150501)-Flight No.1 TEST DATE
TEST CONDITION Take-off, Pitch applied to props
PICK UP LOCATION Pedestal(A) - X Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G²/CPS, GS VOLTS
Y MULTIPLIER 10 1, .1, .01, .001, .0001,
X Units Sec
X Multiplier 1 10, 100, 1000
X Scales


TEST TITLE
TEST DATE
TEST CONDITION
itch applied to pr ps
PICK UP LOCATION
Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units
Y Multipliers 1, 10, 100, 1000
X Scales



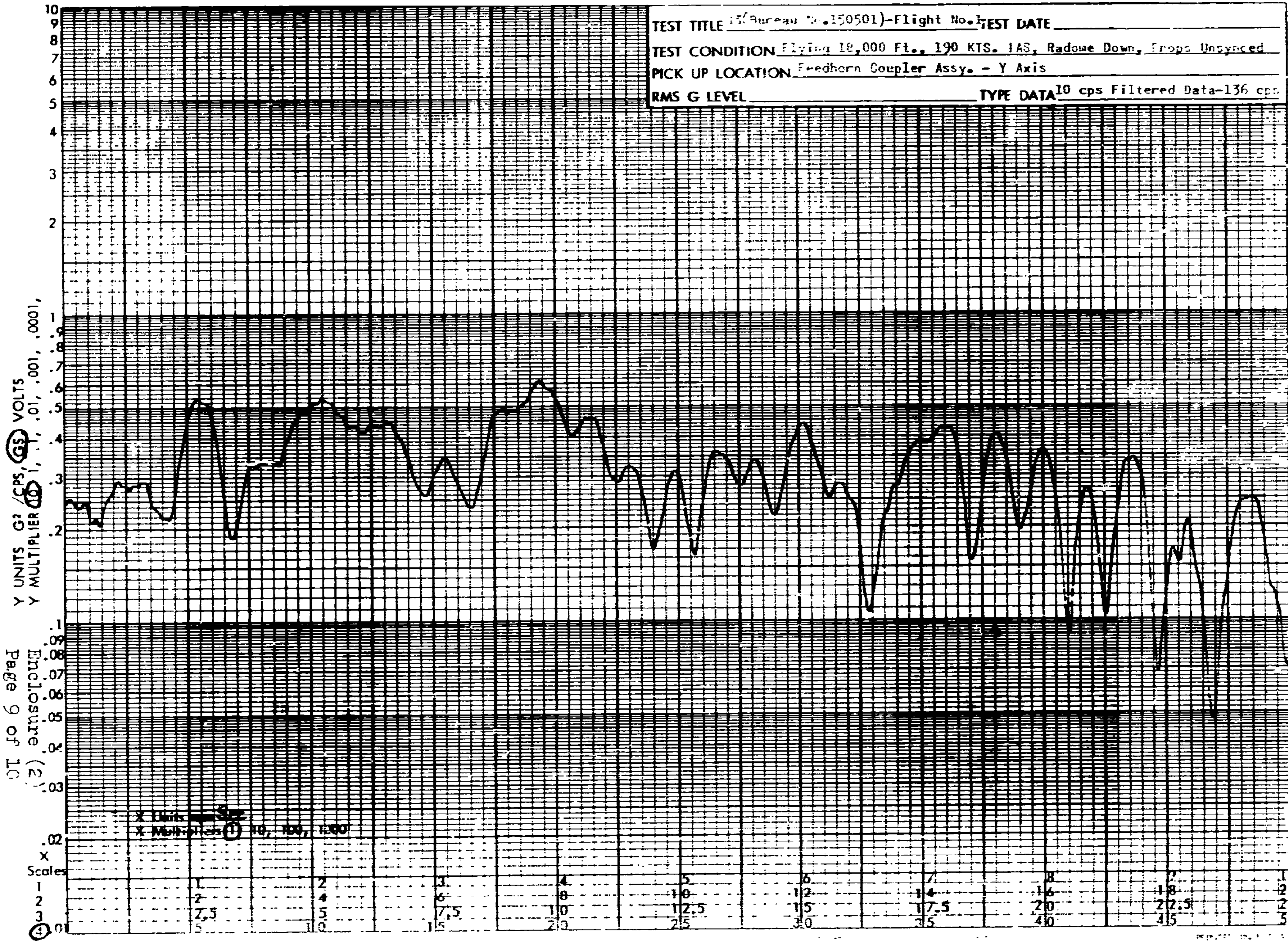
Enclosure (2)
Page 8 of 10

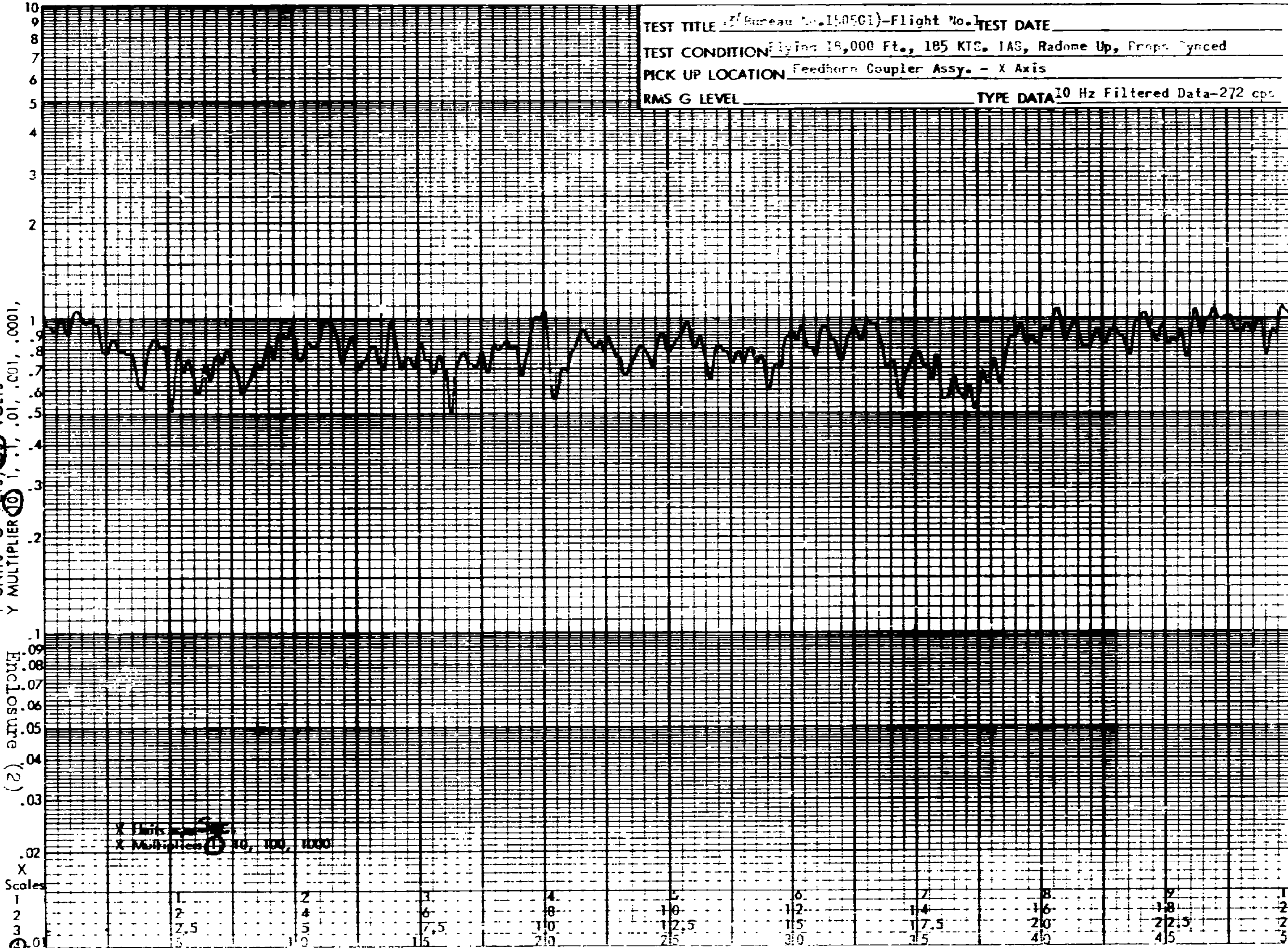
TEST TITLE 15(Bureau No.150501)-Flight No.1 TEST DATE

TEST CONDITION Flying 18,000 Ft., 190 KTS. IAS, Radome Down, Props Unsynced

PICK UP LOCATION Feedhorn Coupler Assy. - Y Axis

RMS G LEVEL TYPE DATA 10 cps Filtered Data-136 cps




TEST TITLE (Bureau No. 150501)-Flight No. 1 TEST DATE
TEST CONDITION Flying 19,000 Ft., 185 KTS. IAS, Radome Up, Props Synced
PICK UP LOCATION Feedhorn Coupler Assy. - X Axis
RMS G LEVEL
TYPE DATA 10 Hz Filtered Data-272 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units
X Multiplier 1, 10, 100, 1000
X Scales

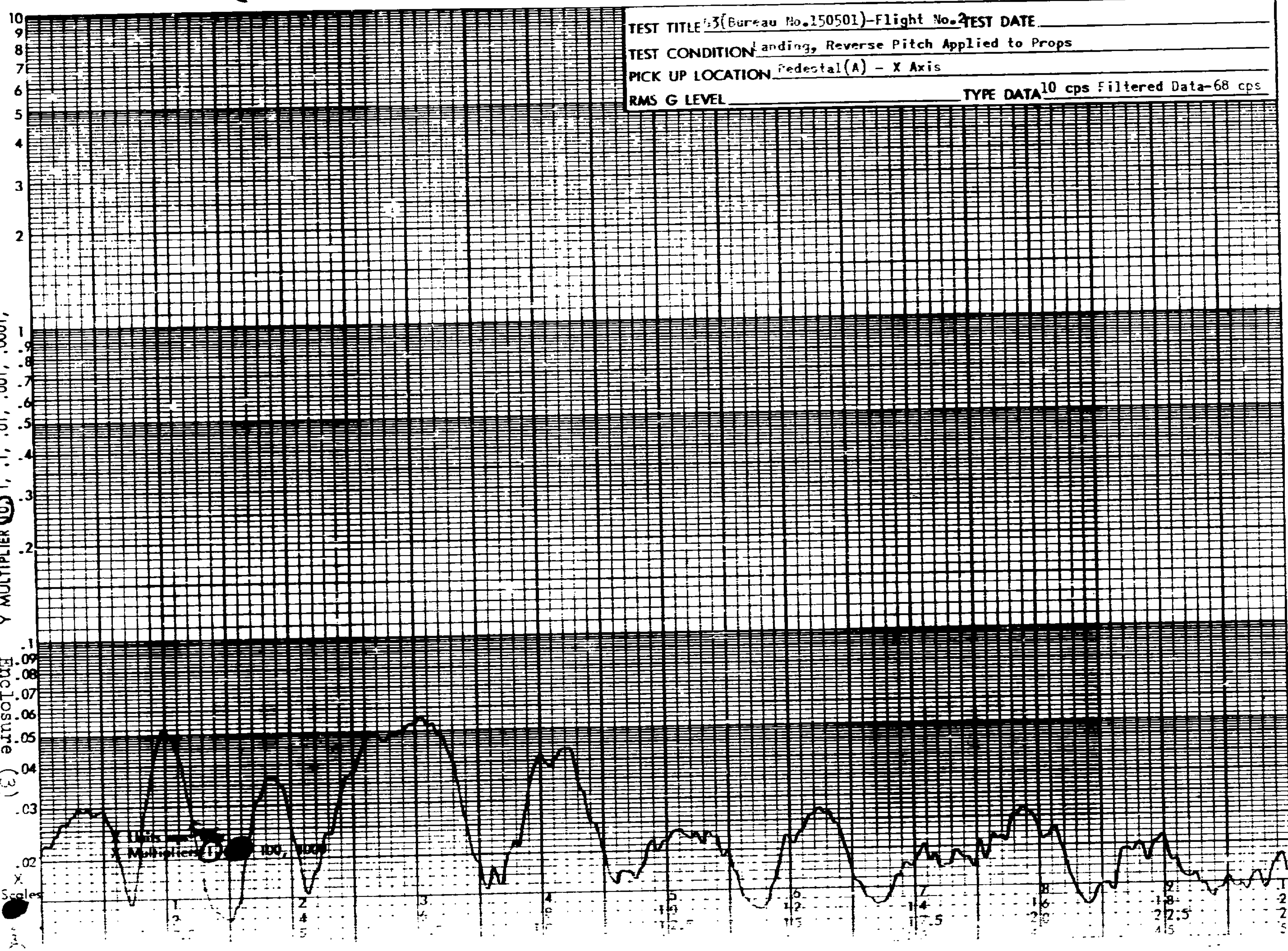
Enclosure (2)

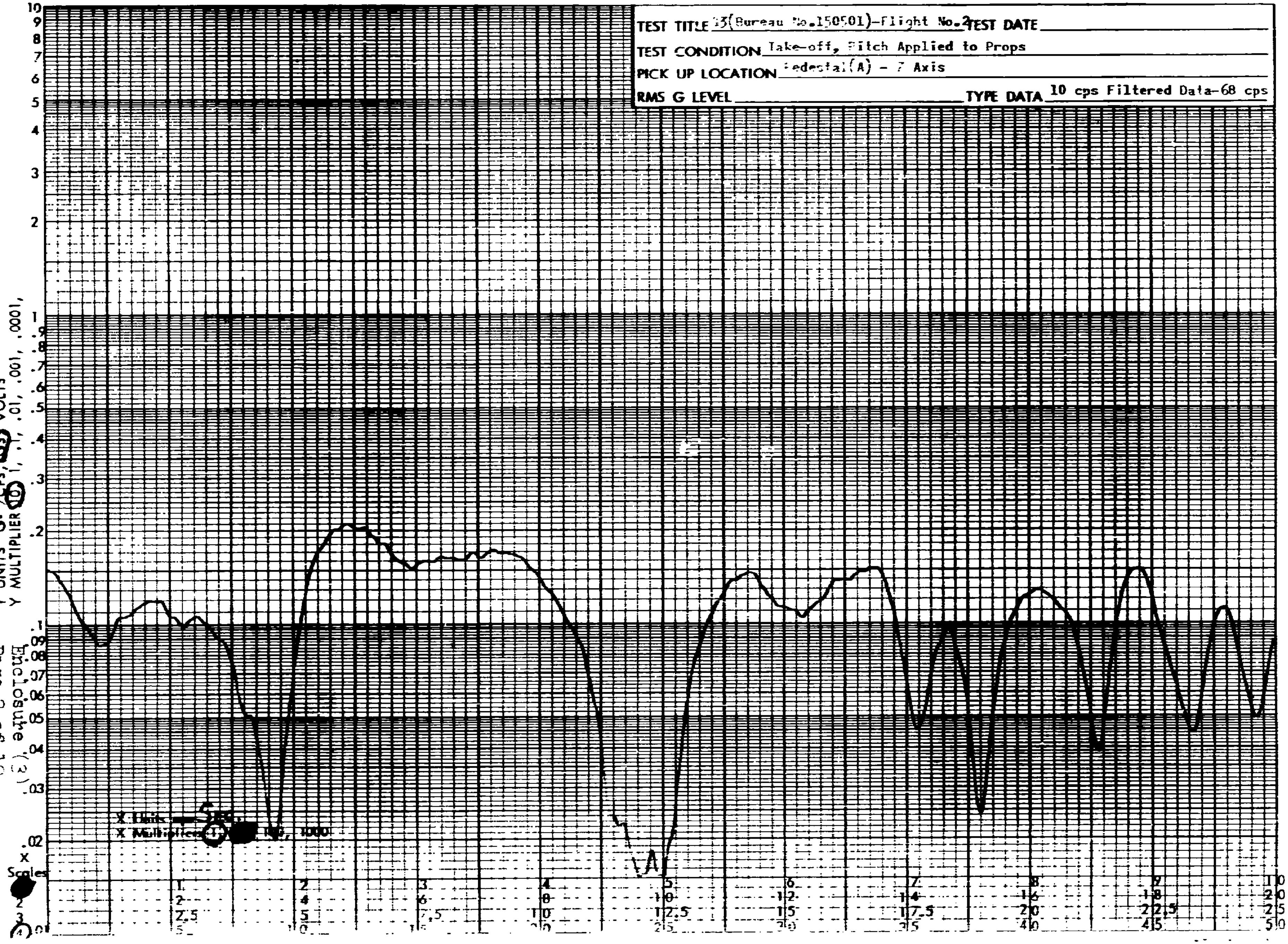
TEST TITLE 53(Bureau No.150501)-Flight No.2 TEST DATE

TEST CONDITION Landing, Reverse Pitch Applied to Props

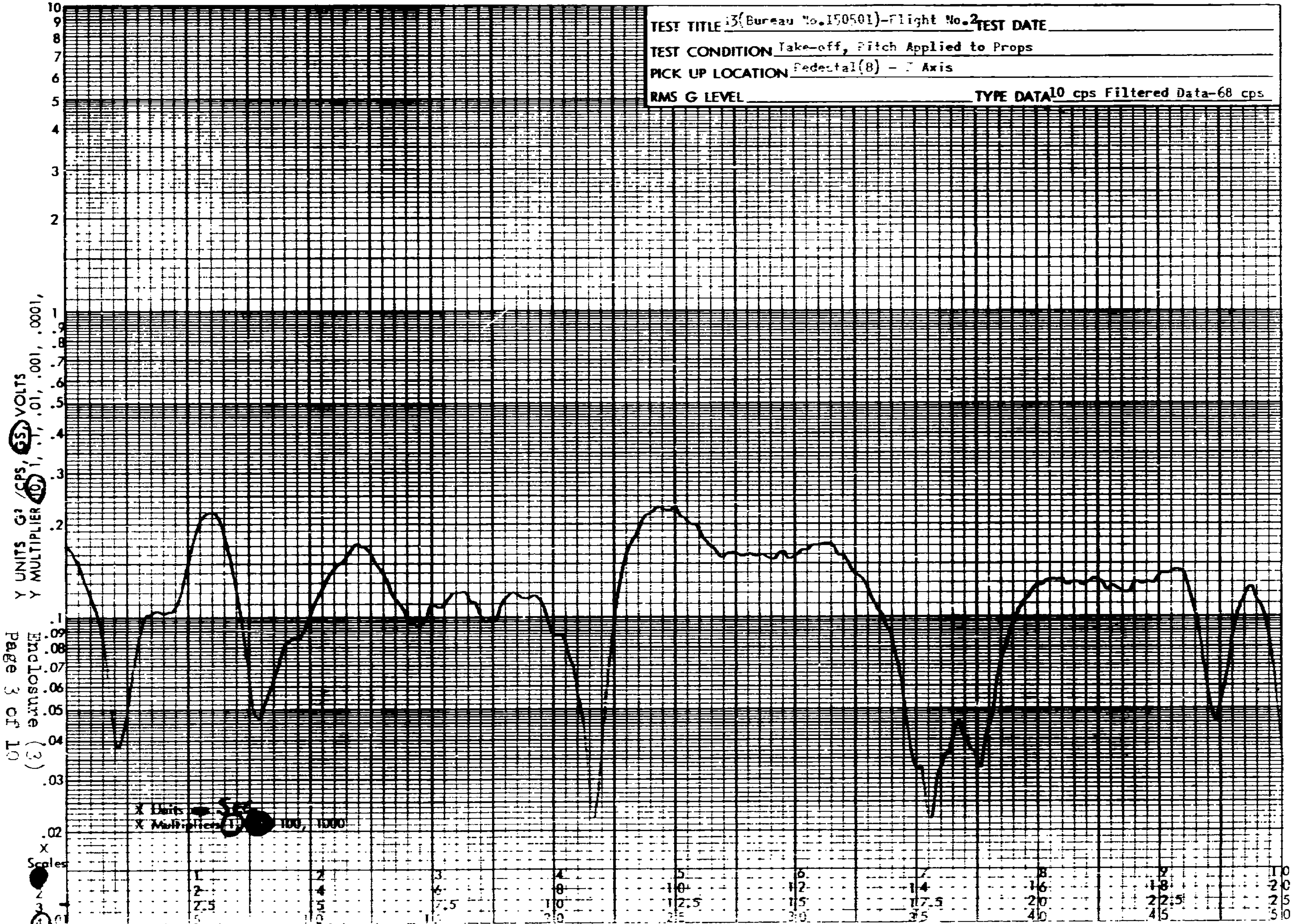
PICK UP LOCATION Pedestal(A) - X Axis

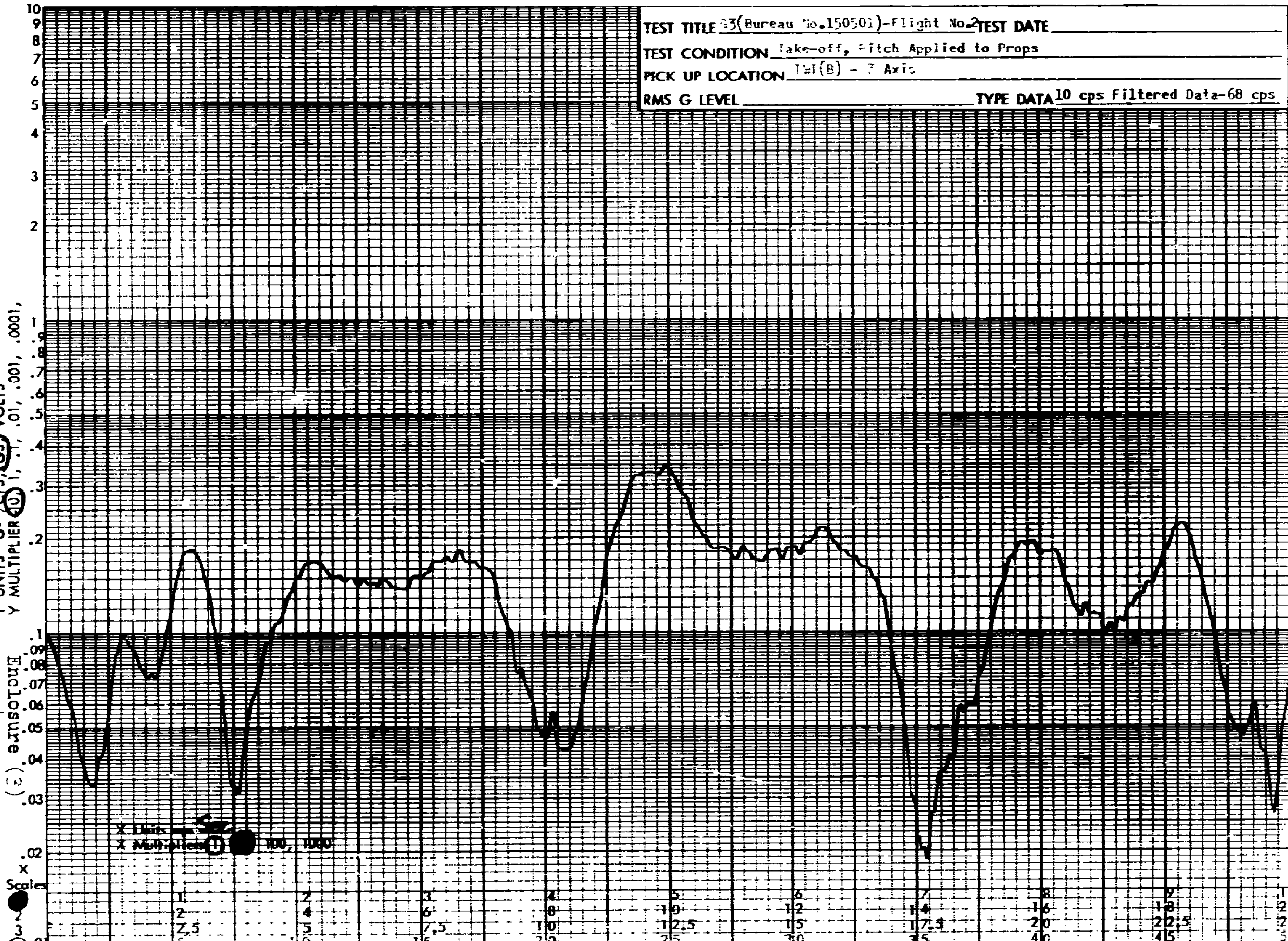
RMS G LEVEL TYPE DATA 10 cps Filtered Data-68 cps



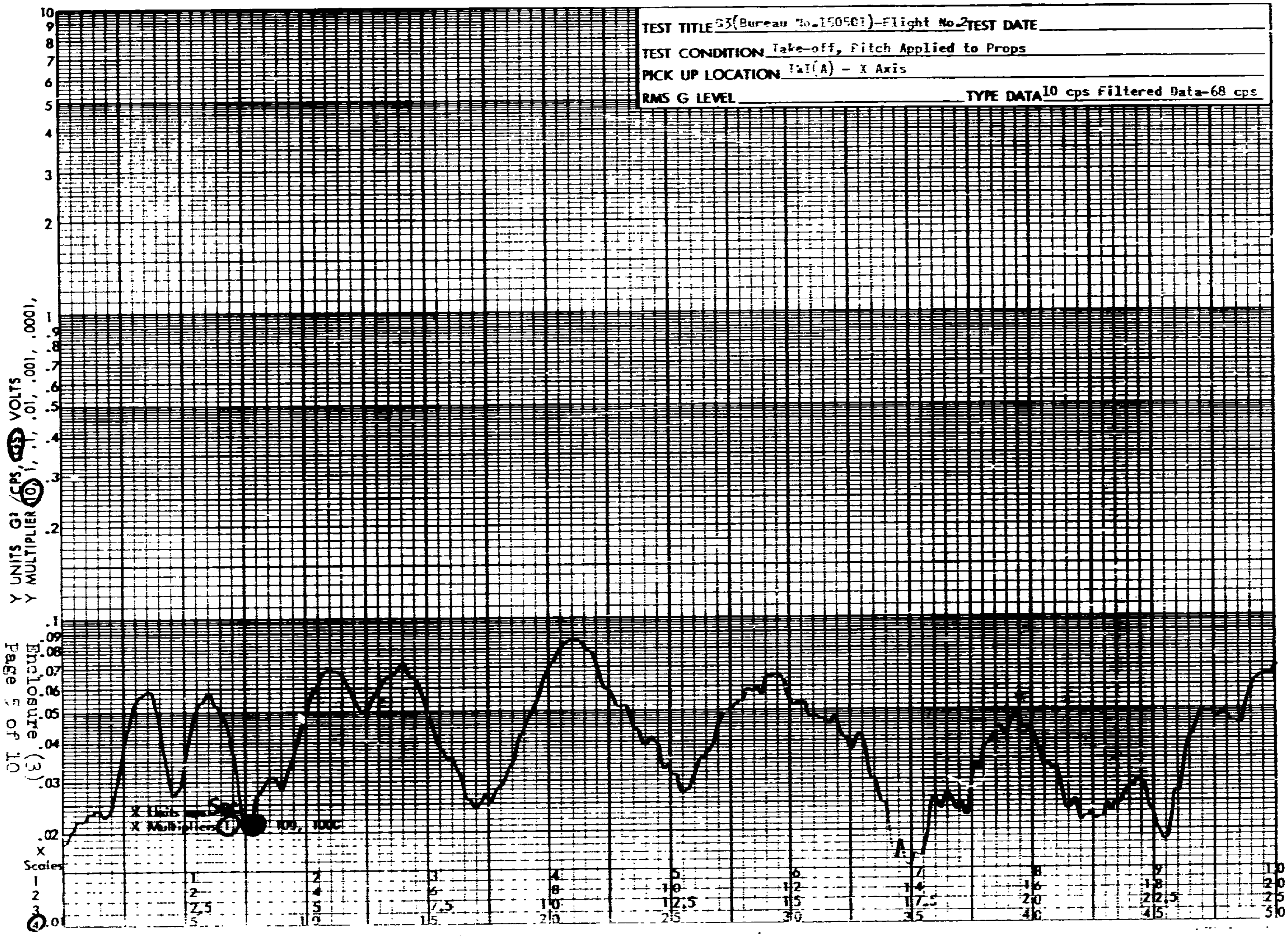


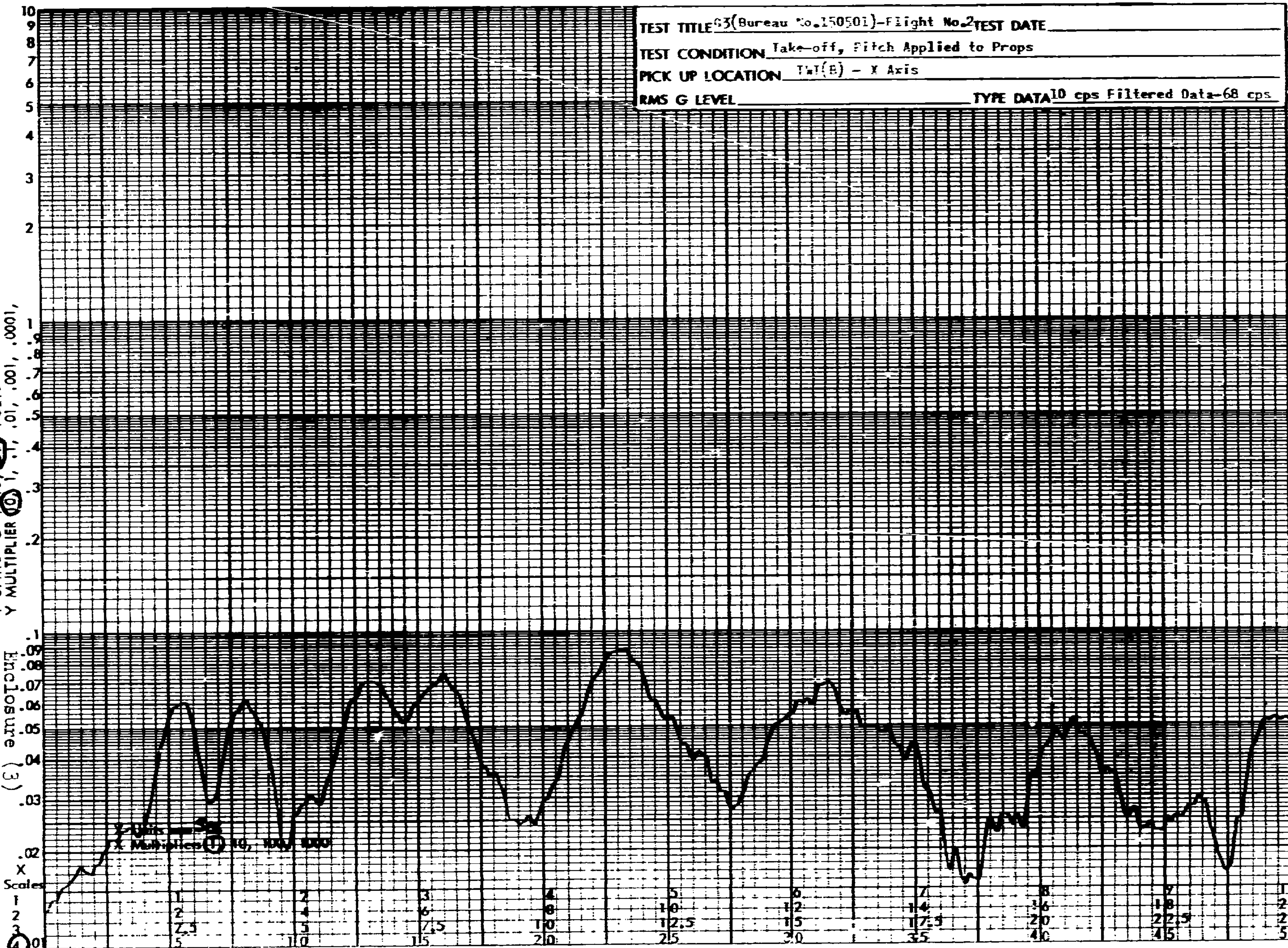
Enclosure (3)
Page 2 of 10

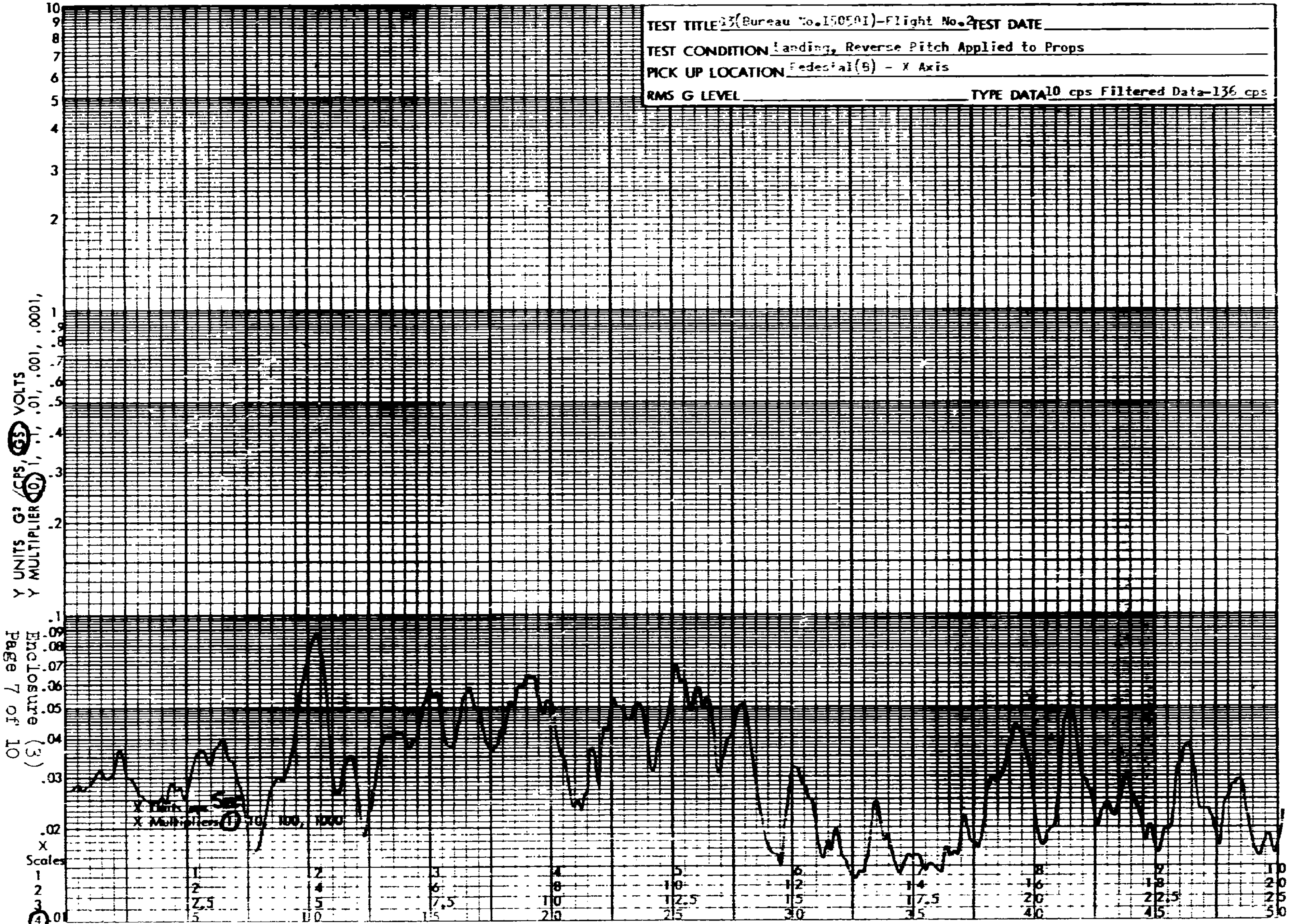

TEST TITLE 13(Bureau No.150501)-Flight No.2 TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION Pedestal(8) - Z Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G² /CPS, G, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001,
X Units
X Multiplier 1, 100, 1000
X Scales


TEST TITLE 33(Bureau No.150501)-Flight No.2 TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION TWI(B) - Z Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units Sec.
X Multiplier 1, 10, 100, 1000
X Scales

Enclosure (3)

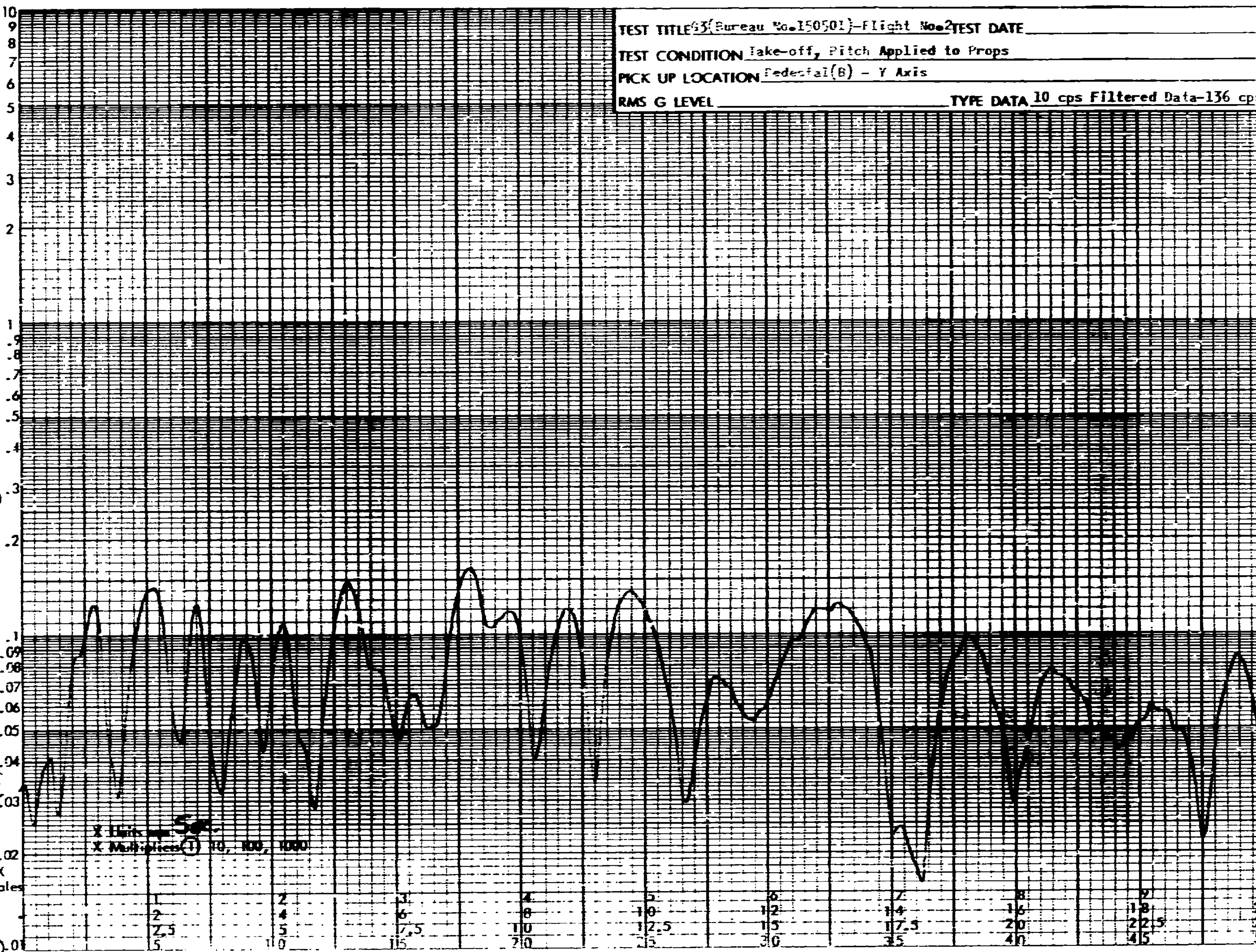

TEST TITLE G3(Bureau No.150501)-Flight No.2 TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION T&T(A) - X Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G²/CPS, CPS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001,
X Units cps
X Multiplier 1, 10, 100, 1000
X Scales
1
2
3
4

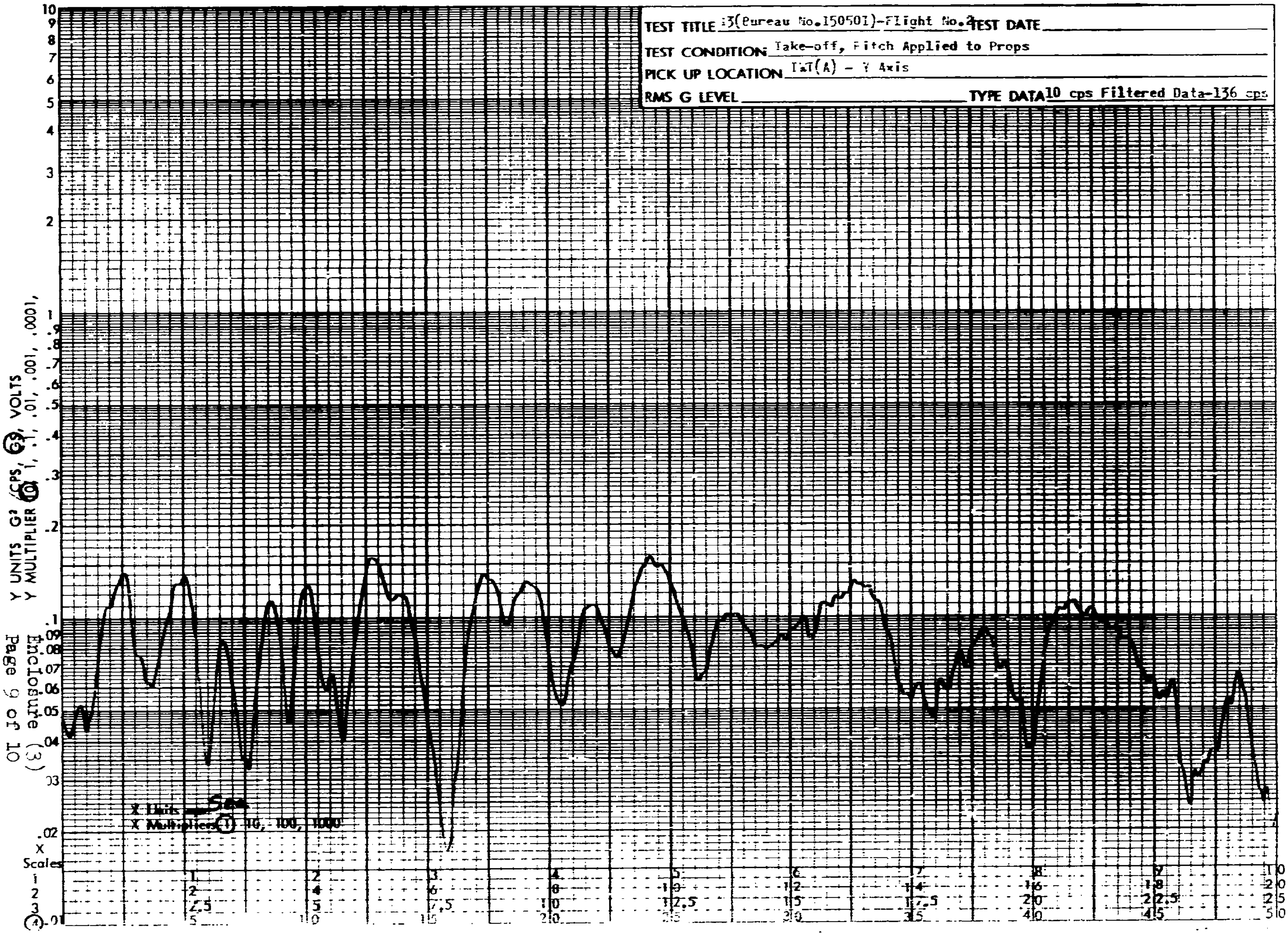

TEST TITLE G3 (Bureau No.150501)-Flight No.2 TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION TWT(B) - X Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-68 cps
Y UNITS G² /CPS, G5 VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units — cps
X Multiplier 1, 10, 100, 1000
X Scales
1
2
3
4

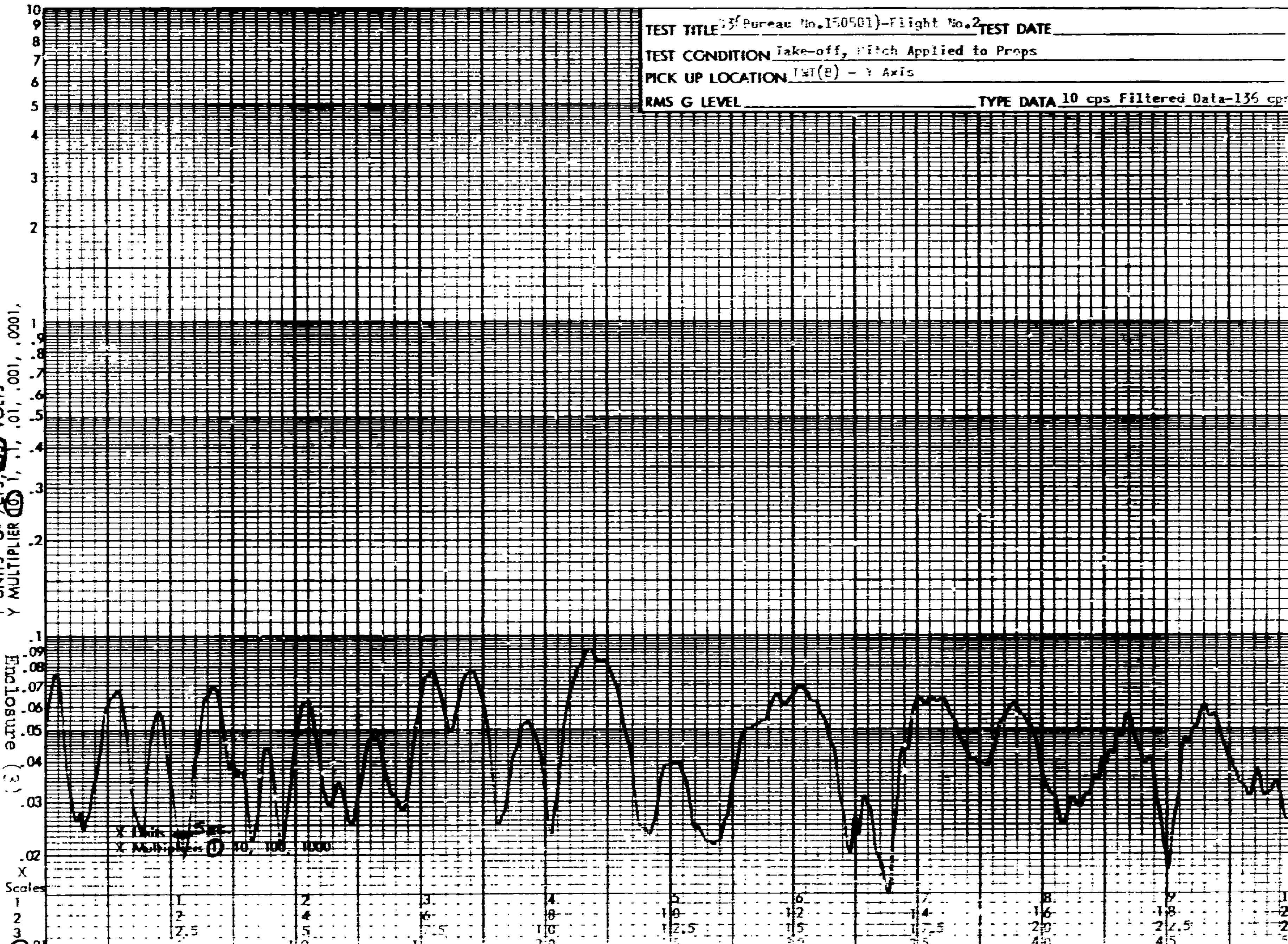


TEST TITLE 23(Bureau No.150501)-Flight No.2 TEST DATE
TEST CONDITION Landing, Reverse Pitch Applied to Props
PICK UP LOCATION Pedestal(6) - X Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-136 cps
Y UNITS G²/CPS, GS, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units 5
X Multipliers 1, 10, 100, 1000
X Scales

Enclosure (3)


TEST TITLE G3 (Bureau No. 150501)-Flight No. 2 TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION Pedestal (B) - Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-136 cps
Y UNITS G² /CPS, (G) VOLTS
Y MULTIPLIER (10) 1, .1, .01, .001, .0001,
X Units Sec.
X Multiplier (1) 10, 100, 1000
X Scales


TEST TITLE 13(Bureau No.150501)-Flight No.2
TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION I&T(A) - Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-136 cps
Y UNITS G²/CPS, G's, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001,
X Units Sec
X Multiplier 1, 10, 100, 1000
X Scales


TEST TITLE 3 (Bureau No.150501)-Flight No.2 TEST DATE
TEST CONDITION Take-off, Pitch Applied to Props
PICK UP LOCATION TSI(B) - Y Axis
RMS G LEVEL
TYPE DATA 10 cps Filtered Data-136 cps
Y UNITS G²/CPS, G's, VOLTS
Y MULTIPLIER 10, 1, .1, .01, .001, .0001
X Units 5 sec.
X Multiplier 1, 10, 100, 1000
X Scales

APPENDIX G

MAXIMUM RANDOM RESPONSES

Enclosure (1) - Tables of Maximum Random Responses for G2

Enclosure (2) - Tables of Maximum Random Responses for G3, Flight No. 1

Enclosure (3) - Tables of Maximum Random Responses for G3, Flight No. 2

Enclosure (4) - Tables of Maximum Random Responses for G5, Flight No. 2

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G2 (Bureau No. 150497)
Flight No: 1
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Flying 17,800 ft., 220 Kts. IAS, Radome up, Props in Sync.	0.00018	500
Pedestal (B)	Flying 17,800 ft., 220 Kts. IAS, Radome descending, Props in Sync.	0.01	270
TWT (A)	Flying 17,800 ft., 220 Kts. IAS, Radome descending, Props in Sync.	0.01	430
TWT (B)	Flying 17,800 ft., 220 Kts. IAS, Radome down, Props out of Sync.	0.00006	500

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G2 (Bureau No. 150497)
Flight No: 1
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Flying 17,800 ft., 220 Kts. IAS, Radome down, Props in Sync.	0.0006	520
Pedestal (B)	Flying 17,800 ft., 220 Kts. IAS, Radome descending, Props out of Sync.	0.00066	1370
TWT (A)	Flying 17,800 ft., 220 Kts. IAS, Radome up, Props out of Sync.	0.004	430
TWT (B)	Flying 17,800 ft., 220 Kts. IAS, Radome down, Props out of Sync.	0.006	150

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G2 (Bureau No. 150497)
Flight No: 1
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Flying 17,800 ft., 225 Kts. IAS, Radome descending, Props in Sync.	0.016	380
Pedestal (B)	Flying 17,800 ft., 225 Kts. IAS, Radome descending, Props in Sync.	0.016	380
TWT (A)	Flying 17,800 ft., 225 Kts. IAS, Radome descending, Props in Sync.	0.046	380
TWT (B)	Take off, Pitch applied to Props	0.004	300
Radome	Flying 17,800 ft., 225 Kts. IAS, Radome descending, Props in Sync.	0.06	270

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 1
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Flying 18,000 ft., 185 Kts. IAS, Radome being retracted, Props in Sync.	0.008	270
Feedhorn Assembly	Flying 17,800 ft., 190 Kts. IAS, Radome down, Props in Sync.	0.002	500
Feedhorn Coupler	Flying 18,000 ft., 185 Kts. IAS, Radome up, Props in Sync.	0.72	380
Isolation System	Landing, Reverse Pitch applied to Props	0.016	750

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 1
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Flying 18,000 ft., 190 Kts. IAS, Radome down, Props out of Sync.	.000082	500
Feedhorn Assembly	Flying 18,000 ft., 190 Kts. IAS, Radome descending, Props in Sync.	0.001	1750
Feedhorn Coupler	Flying 18,000 ft., 190 Kts. IAS, Radome descending, Props in Sync.	0.006	500
Isolation System	Landing, Reverse Pitch applied to Props	0.01	170
Radome	Take off, Lift off	0.0008	300

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 1
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Take off, Pitch applied to Props	0.02	140
Feedhorn Assembly	Take off, Pitch applied to Props	0.002	1710
Feedhorn Coupler	Flying 18,000 ft., 230 Kts. IAS, Radome down, Props in Sync.	0.00072	500
Isolation System	Flying 18,000 ft., 230 Kts. IAS, Radome descending, Props in Sync.	0.16	270

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 2
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Landing, Reverse Pitch applied to Props	0.0004	500
Pedestal (B)	Flying 2000 ft., 175 Kts. IAS, Radome up, Props in Sync.	0.0024	1590
TWT (A)	Landing, Reverse Pitch applied to Props	0.004	1100
TWT (B)	Flying 1800 ft., 154 Kts. IAS, Radome down, Props out of Sync.	0.0002	1590

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 2
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Radome down, Props in Sync., Sectoring Antenna, ± 10° at 6 RPM	.000014	400
Pedestal (B)	Flying 2000 ft., 165 Kts. IAS, Radome down, Props in Sync.	0.004	1590
TWT (A)	Landing, Reverse Pitch applied to Props	0.0008	1100
TWT (B)	Landing, Reverse Pitch applied to Props	0.00028	340

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G3 (Bureau No. 150501)
Flight No: 2
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (A)	Flying 2000 ft., 173 Kts. IAS, Radome down, Props in Sync.	0.0022	500
Pedestal (B)	Taxiing after Landing	0.004	380
TWT (A)	Landing, Reverse Pitch applied to Props	0.00001	500
TWT (B)	Landing, Reverse Pitch applied to Props	0.0014	340

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G5 (Bureau No. 150502)
Flight No: 2
Axis: X

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (B)	Flying 19,000 ft., 245 Kts. IAS, Radome down*	0.0012	970
Feedhorn Assembly	Take off, Pitch applied to Props	0.01	940
TWT (A)	Flying 17,000 ft., 228 Kts. IAS, Radome down*	0.006	1040

*Flight conditions of props in and out of sync. were not used during Flight Tests for G5.

Enclosure (4)

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G5 (Bureau No. 150502)
Flight No: 2
Axis: Y

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Feedhorn Assembly	Take off, Pitch applied to Props	0.06	1370
TWT (A)	Flying 17,000 ft., 228 Kts. IAS, Radome down	0.016	110

TABLE OF MAXIMUM RANDOM RESPONSES

Plane No: G5 (Bureau No. 150502)
Flight No: 2
Axis: Z

Accelerometer Mounting Location	Flight Test Condition	Maximum Random Response (g^2/Hz)	Frequency (Hz)
Pedestal (B)	Flying 19,000 ft., 220 Kts. IAS, Radome down*	0.0004	1270
Feedhorn Assembly	Take off, Pitch applied to Props	0.02	1370
TWT (A)	Flying 17,000 ft., 228 Kts. IAS, Radome down*	0.002	300
Isolation System	Flying 21,000 ft., 245 Kts. IAS, Radome descending*	0.16	310
Radome	Flying 21,000 ft., 245 Kts. IAS, Radome up*	0.08	150

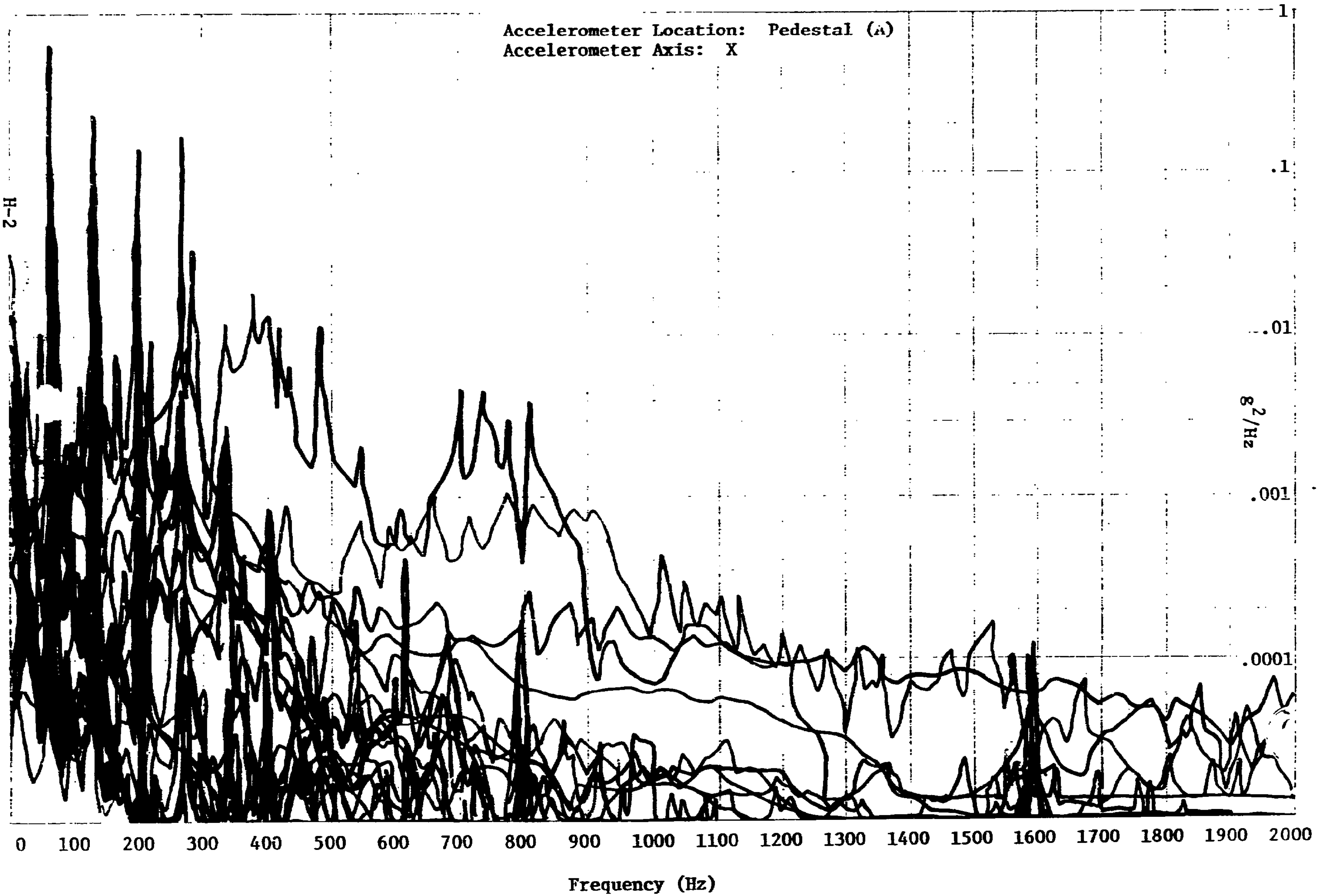
*Flight conditions of props in and out of sync. were not used during Flight Tests for G5.

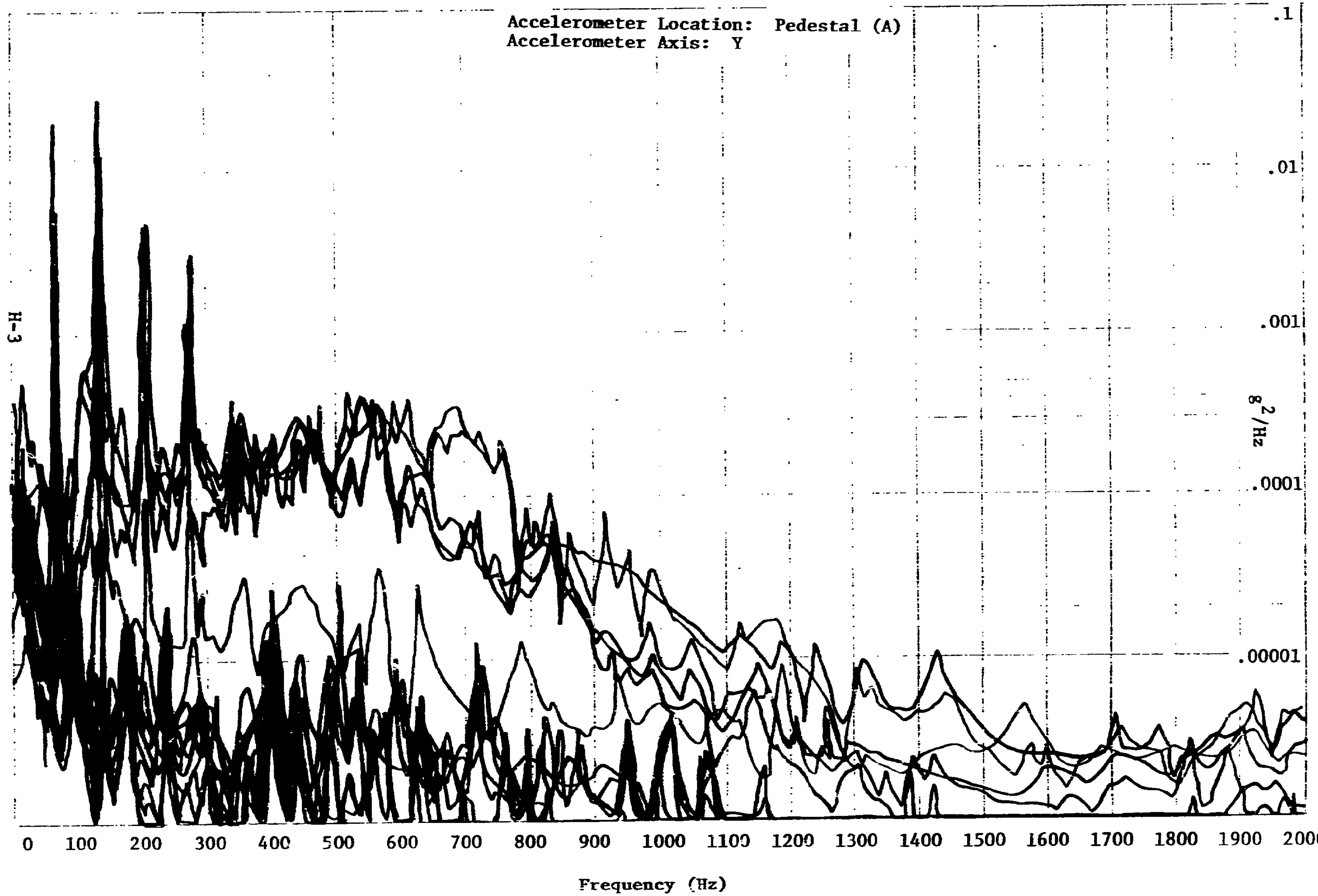
APPENDIX H

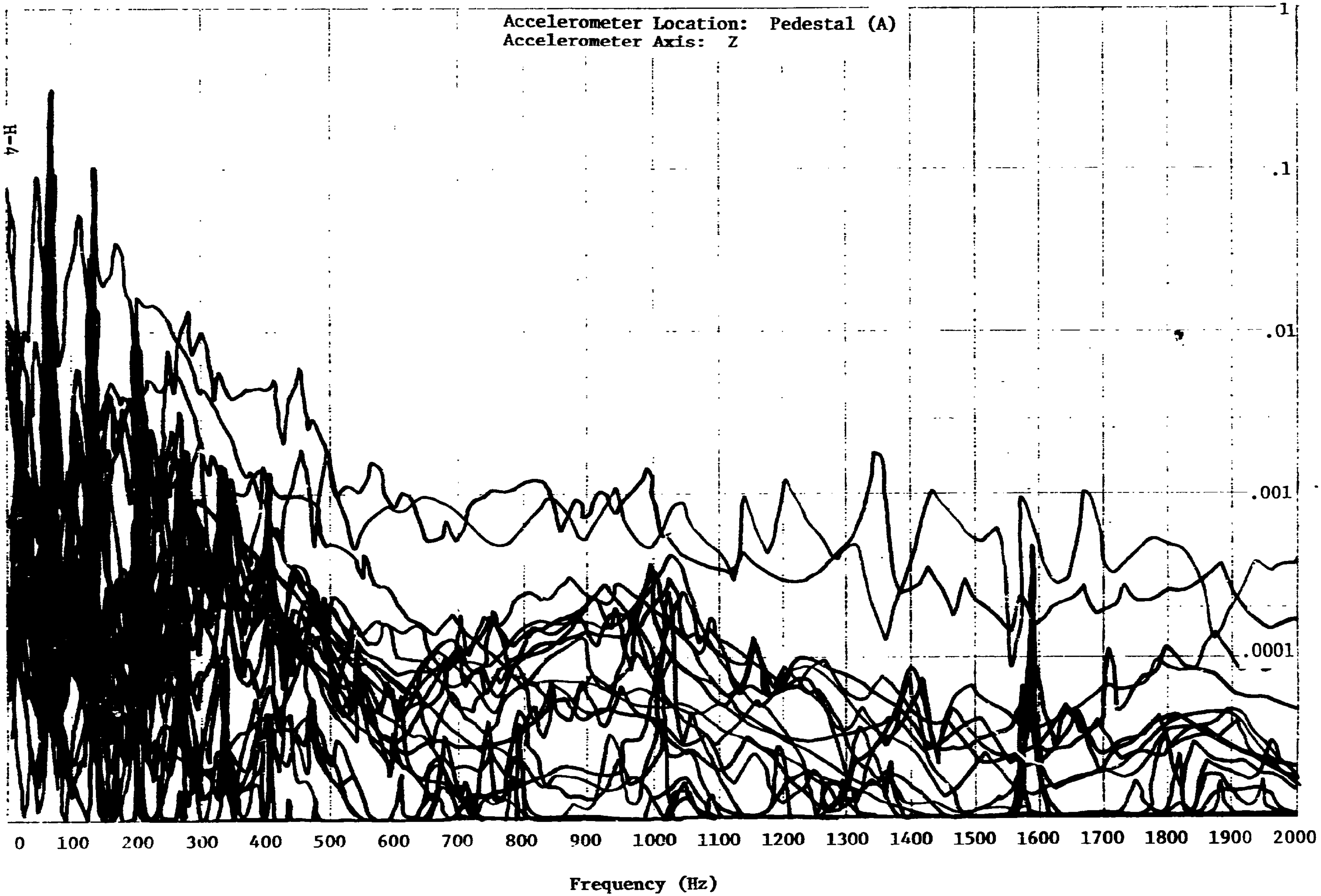
COMPOSITE GRAPHS

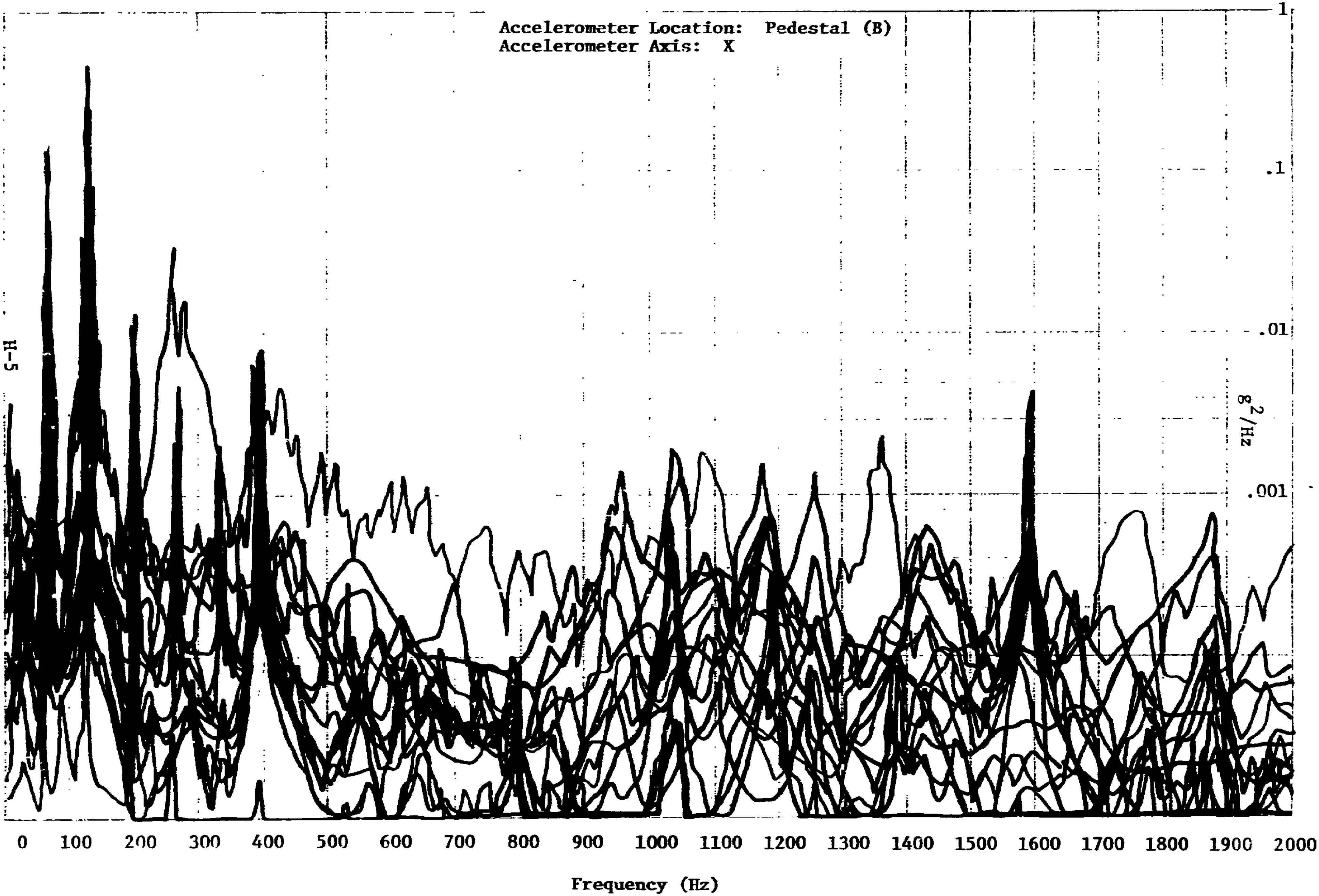
Each of the Composite Graphs detailed within this Appendix includes all of the available vibration data that was obtained for the Big Look Antenna Assembly (AS-2879/APS) during Flight Tests at Hayes International, Birmingham, Alabama, and NAS Moffett Field, Mountain View, California.

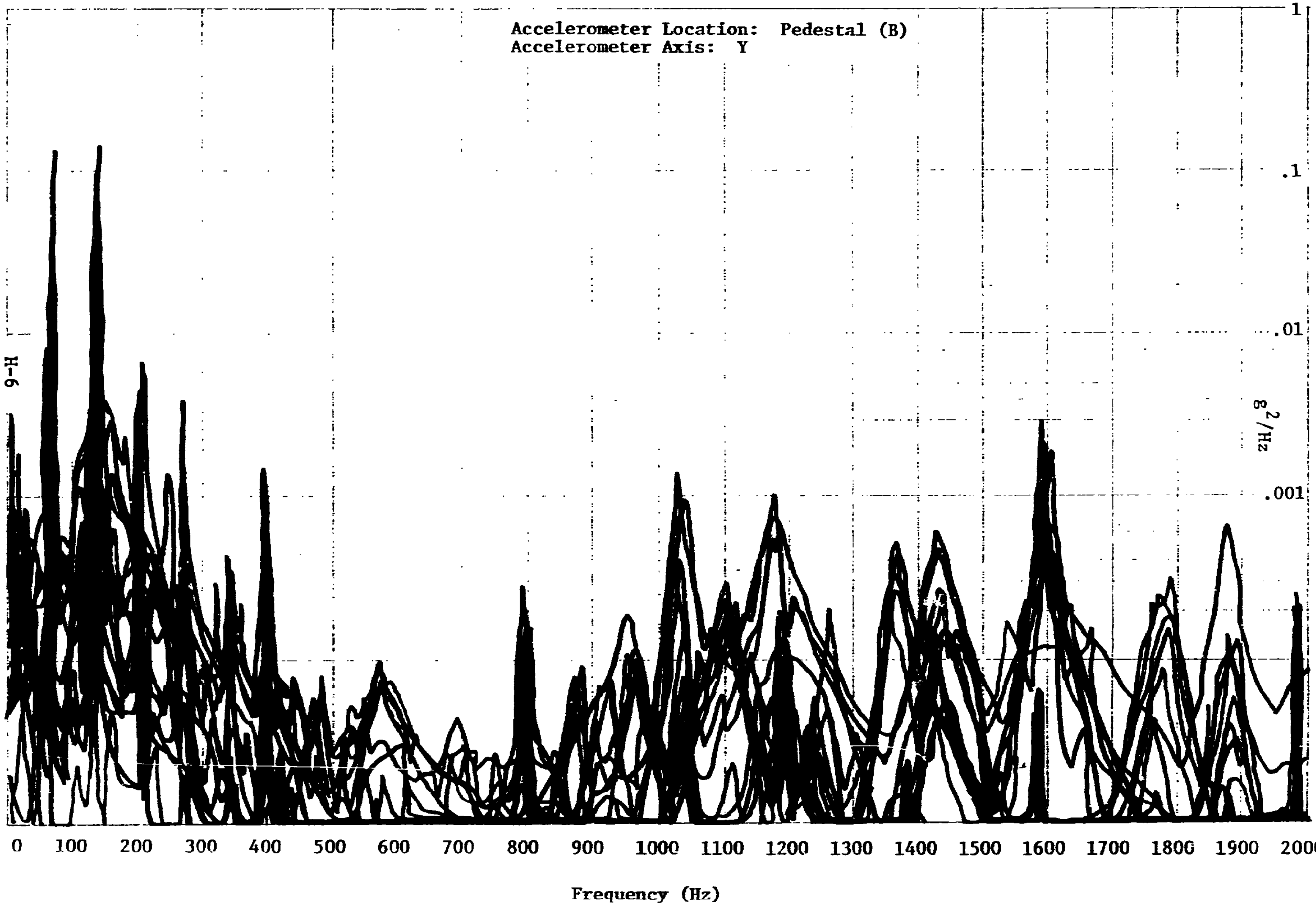
The Composite Graphs include the vibration data for the monitored locations of Pedestal (A), Pedestal (B), TWT (A), TWT (B), Feedhorn Assembly, Feedhorn Coupler, Isolation System, and Radome for the EP-3E Aircraft designated as G2, G3, and G5. The graphs are so designated if the data shown are for only one of the three Aircraft.

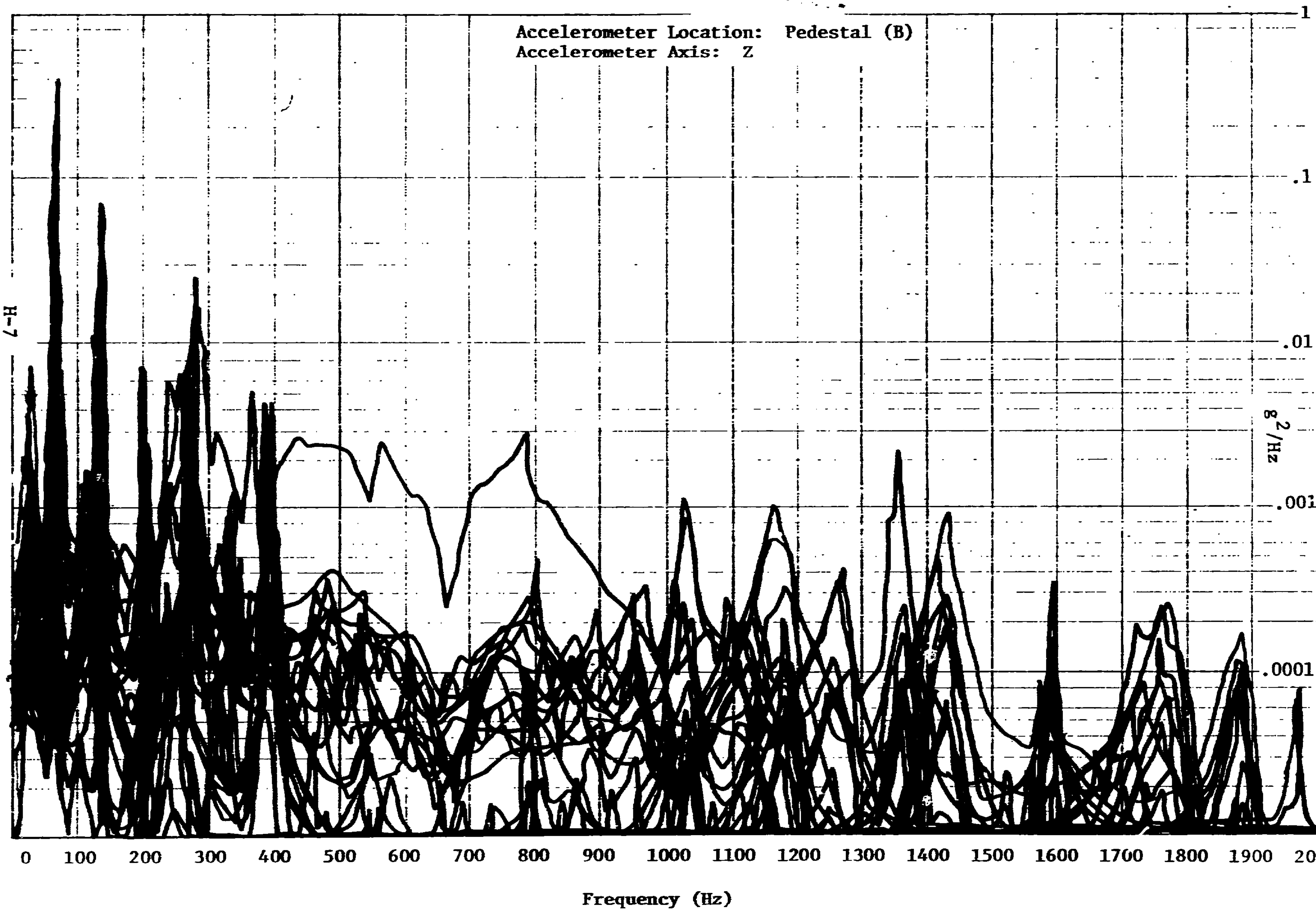

Accelerometer Location: Pedestal (A)
Accelerometer Axis: X
1
.1
.01
.001
.0001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)


Accelerometer Location: Pedestal (A)
Accelerometer Axis: Y
.1
.01
.001
.0001
.00001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

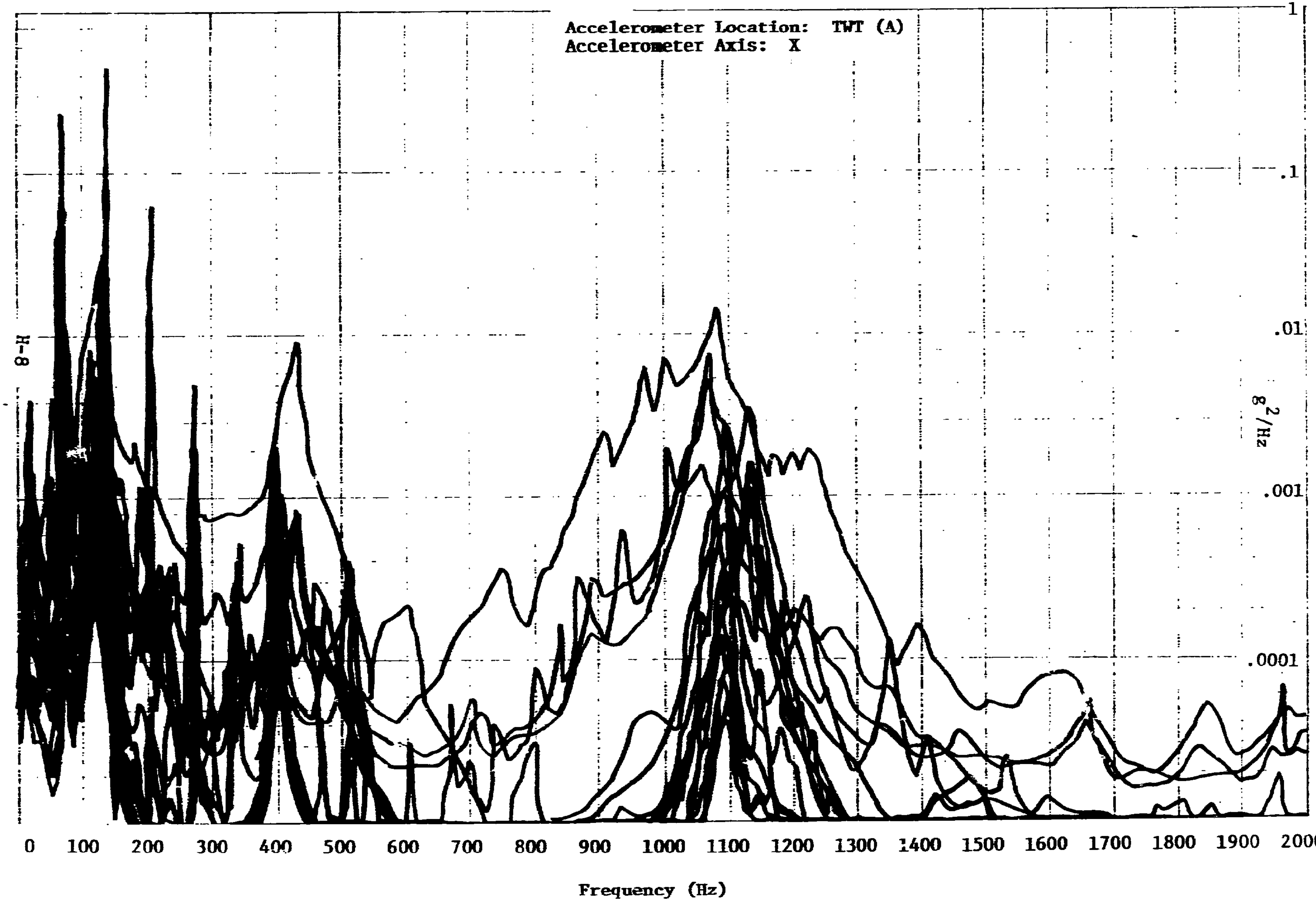

Accelerometer Location: Pedestal (A)
Accelerometer Axis: Z
1
.1
.01
.001
.0001
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

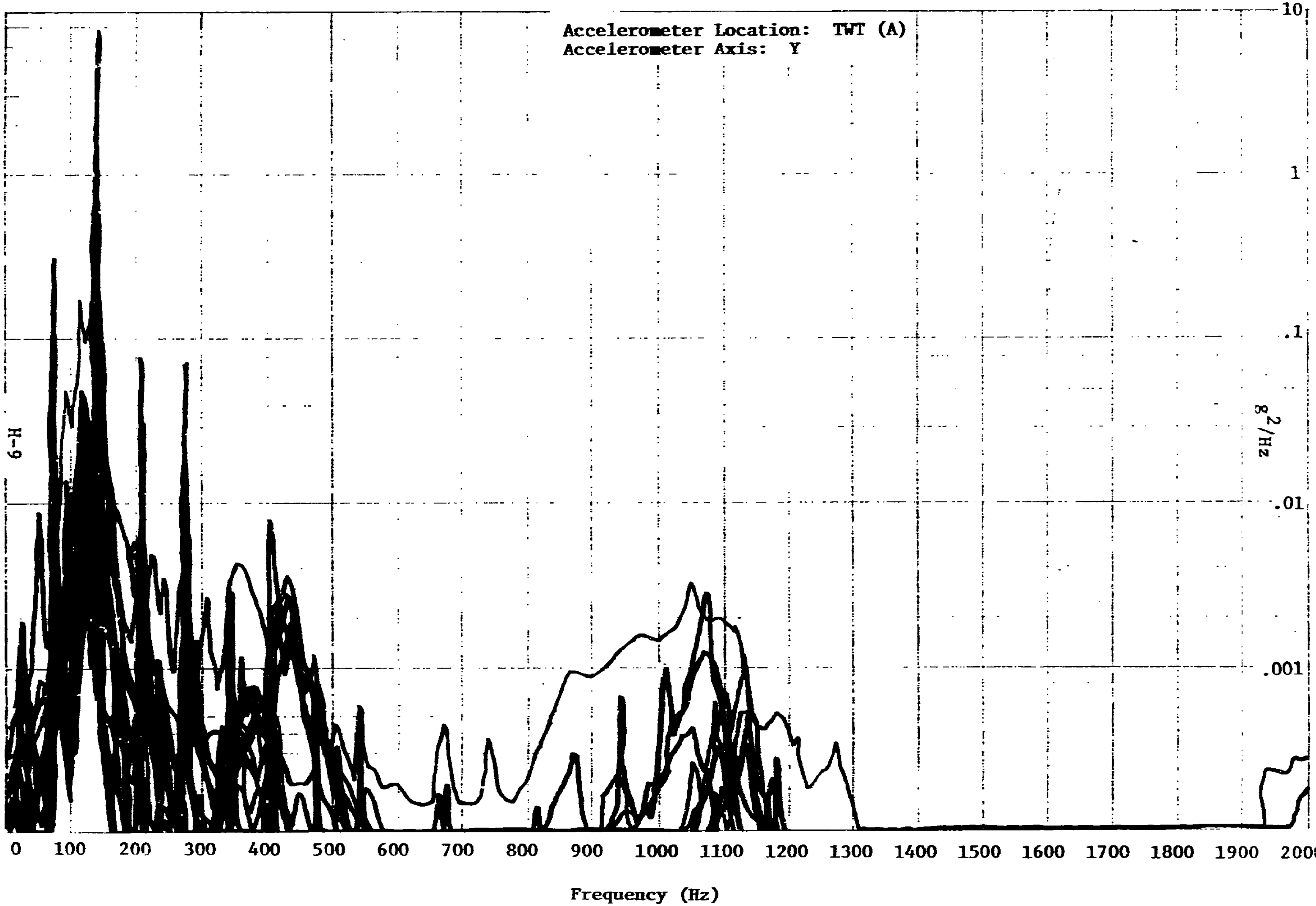

Accelerometer Location: Pedestal (B)
Accelerometer Axis: X
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

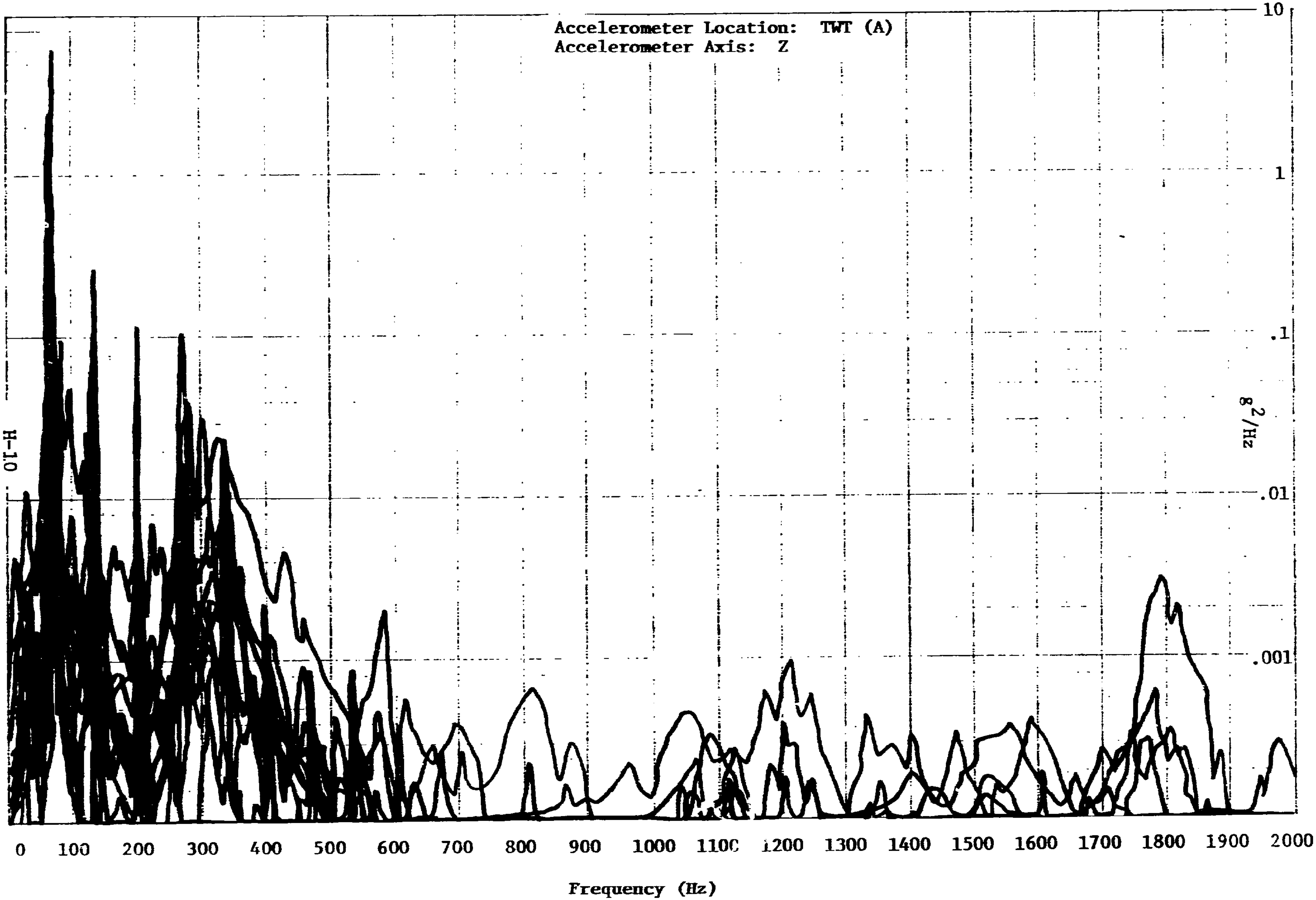

Accelerometer Location: Pedestal (B)
Accelerometer Axis: Y
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

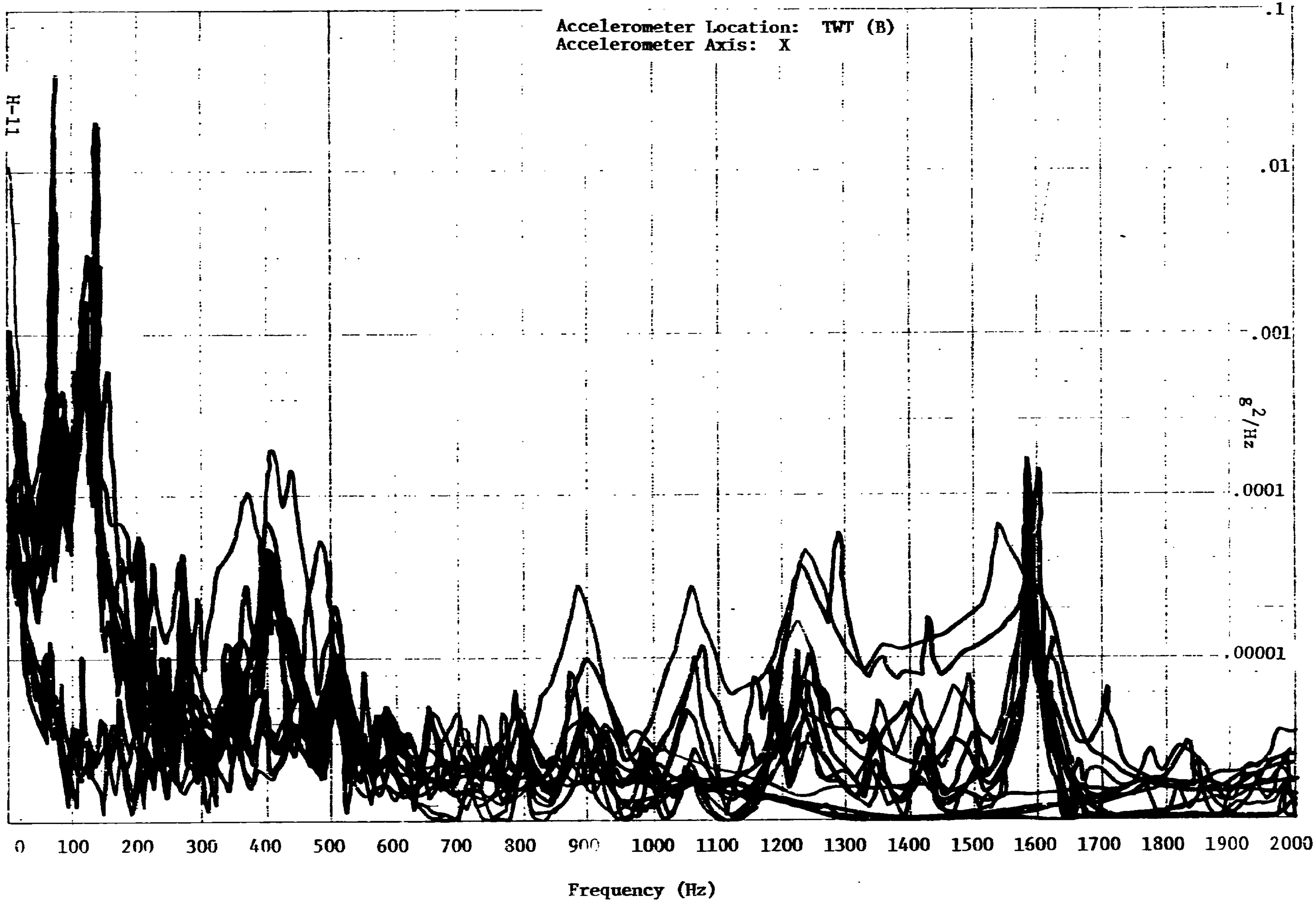


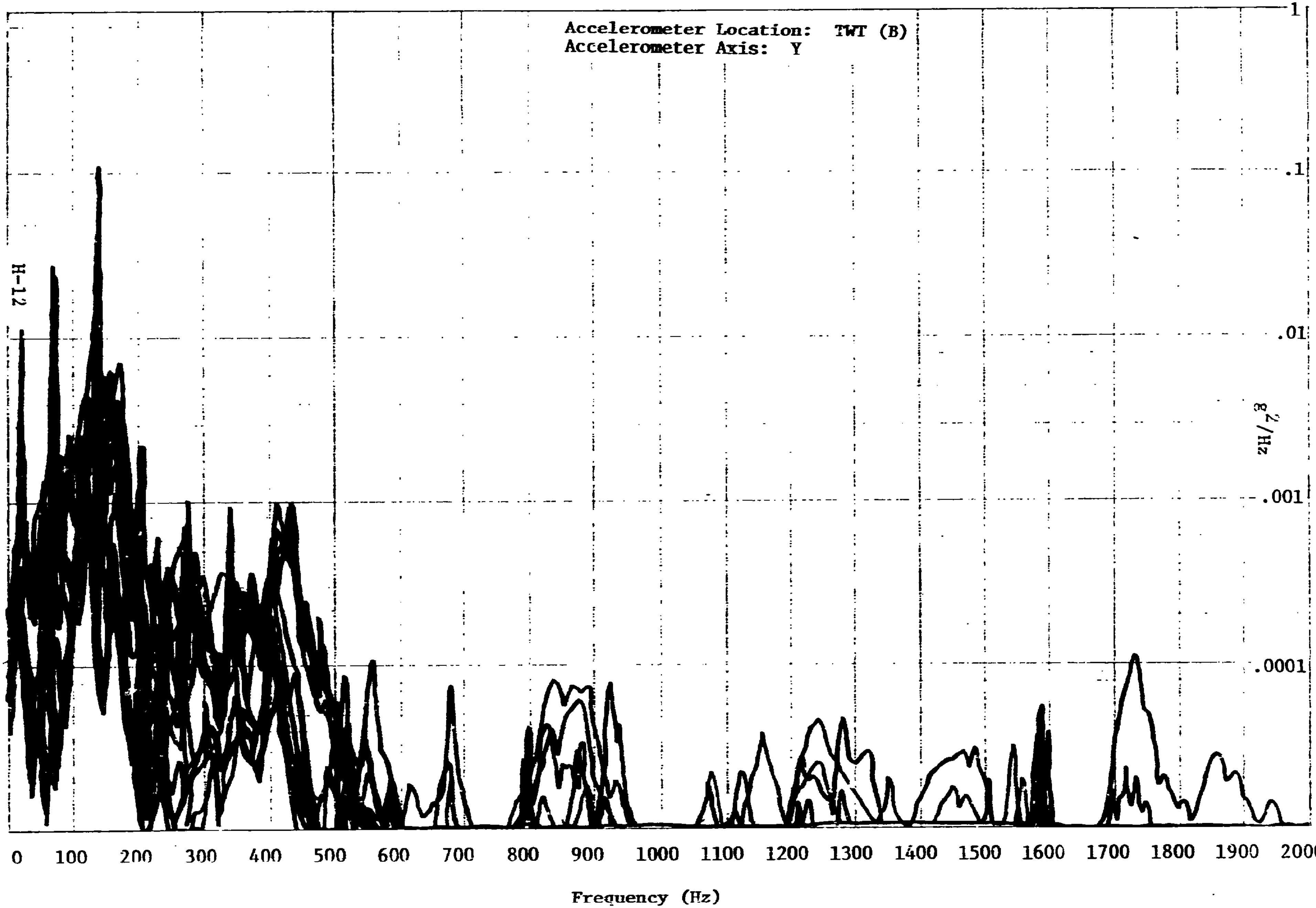
Accelerometer Location: Pedestal (B)
Accelerometer Axis: Z
1
.1
.01
.001
.0001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

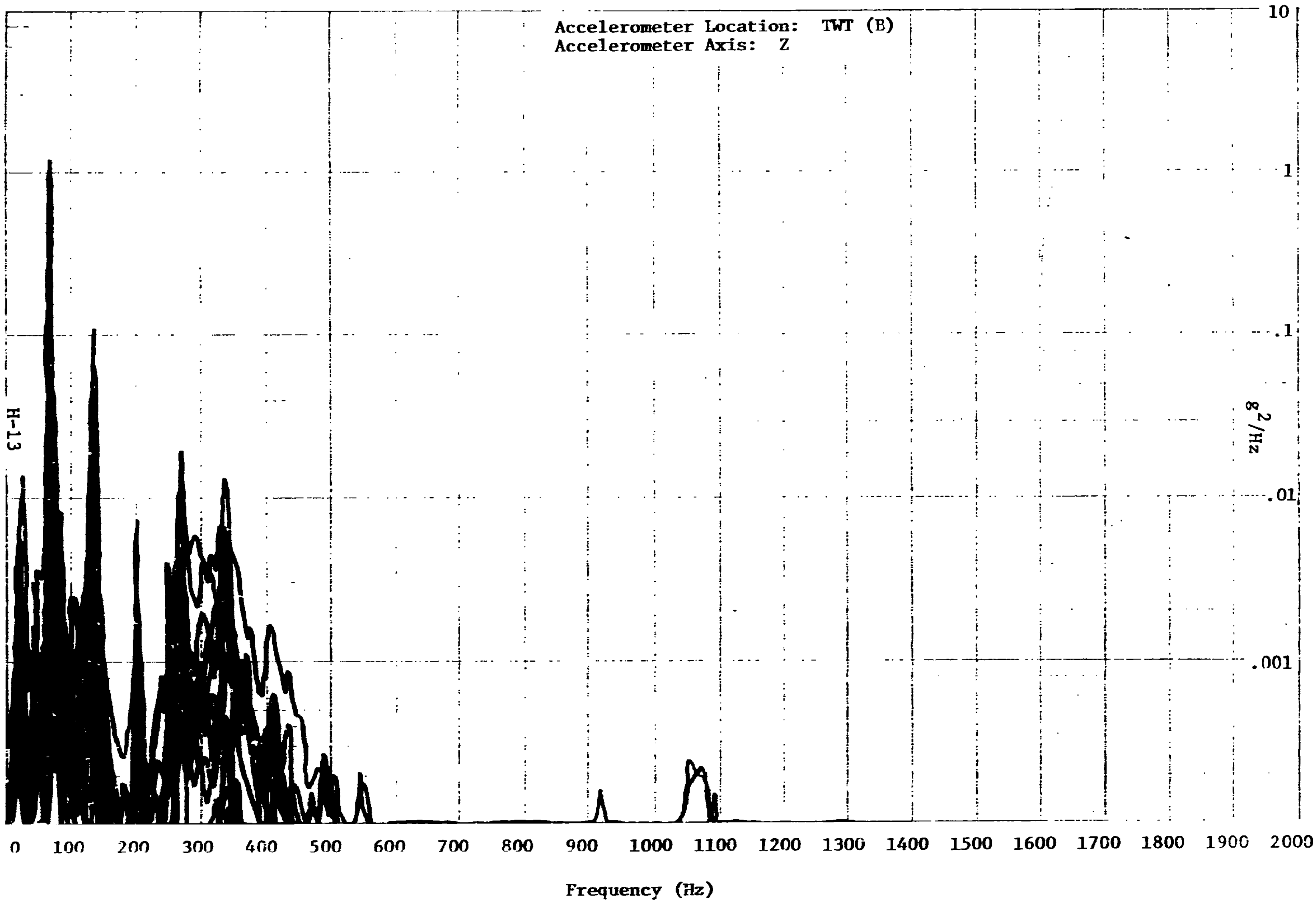

Accelerometer Location: TWT (A)
Accelerometer Axis: X
1
.1
.01
.001
.0001
g²/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)


Accelerometer Location: TWT (A)
Accelerometer Axis: Y
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

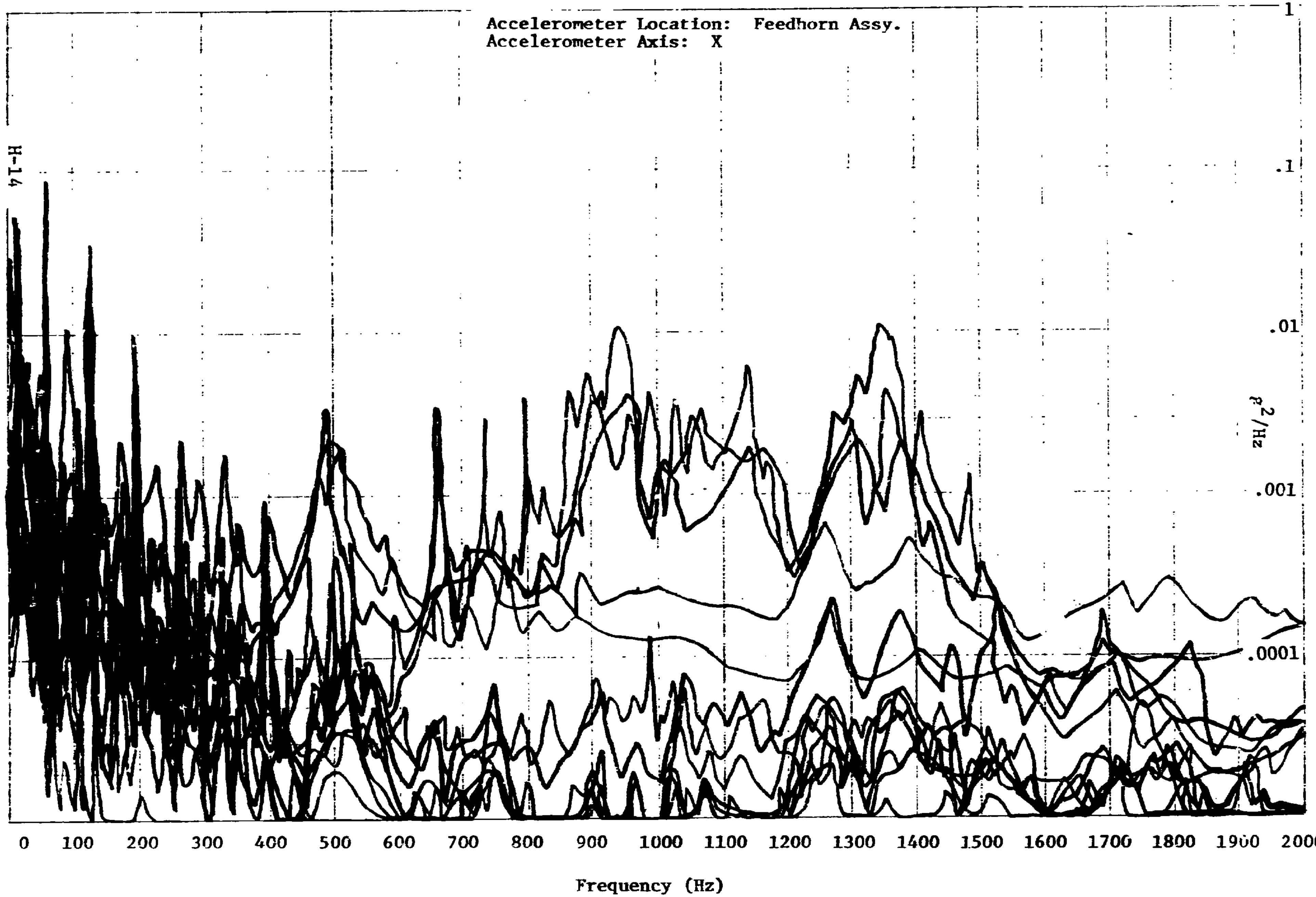

Accelerometer Location: TWT (A)
Accelerometer Axis: Z
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)


Accelerometer Location: TWT (B)
Accelerometer Axis: X
.1
.01
.001
.0001
.00001
g²/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

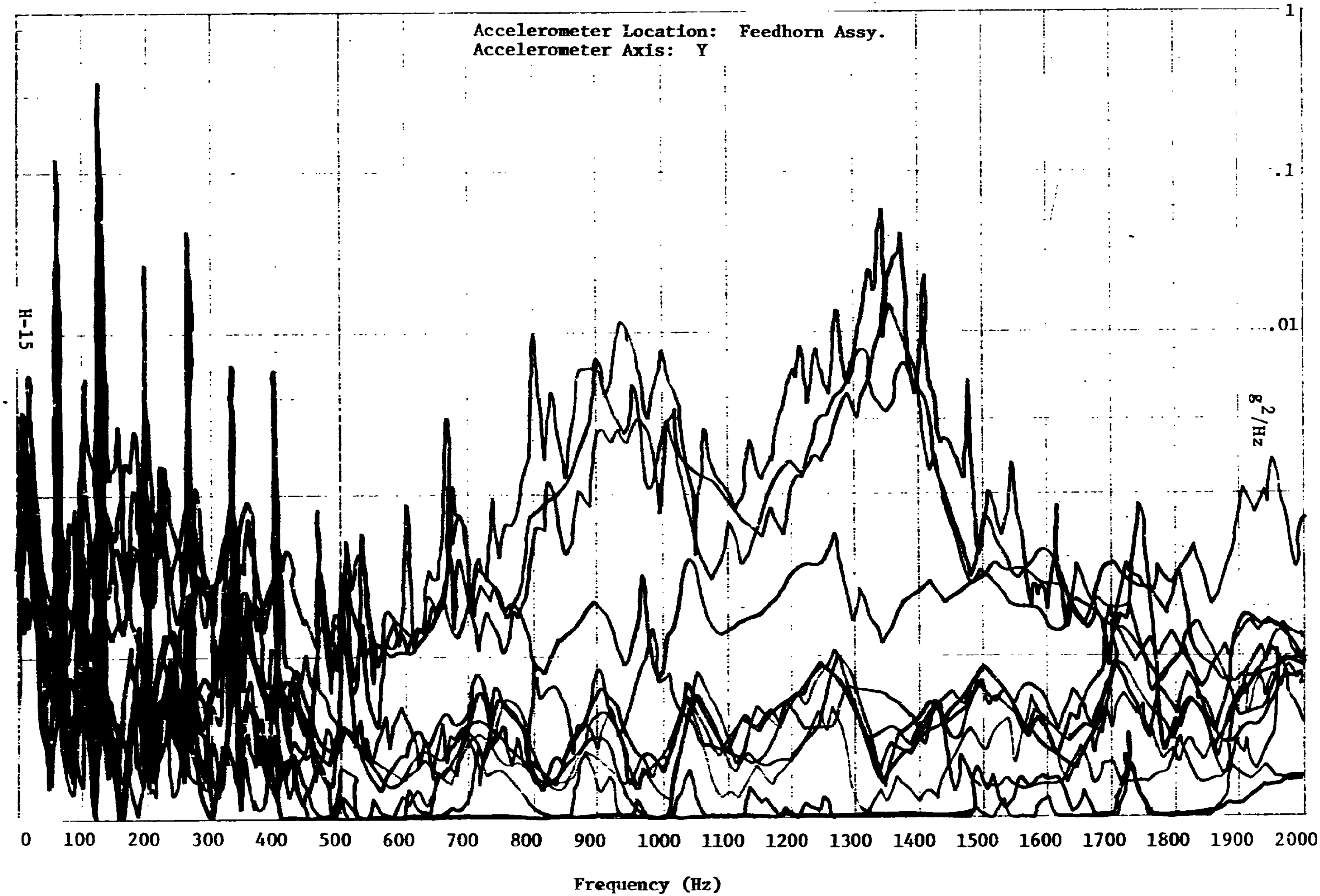

Accelerometer Location: TWT (B)
Accelerometer Axis: Y
g²/Hz
1
.1
.01
.001
.0001
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

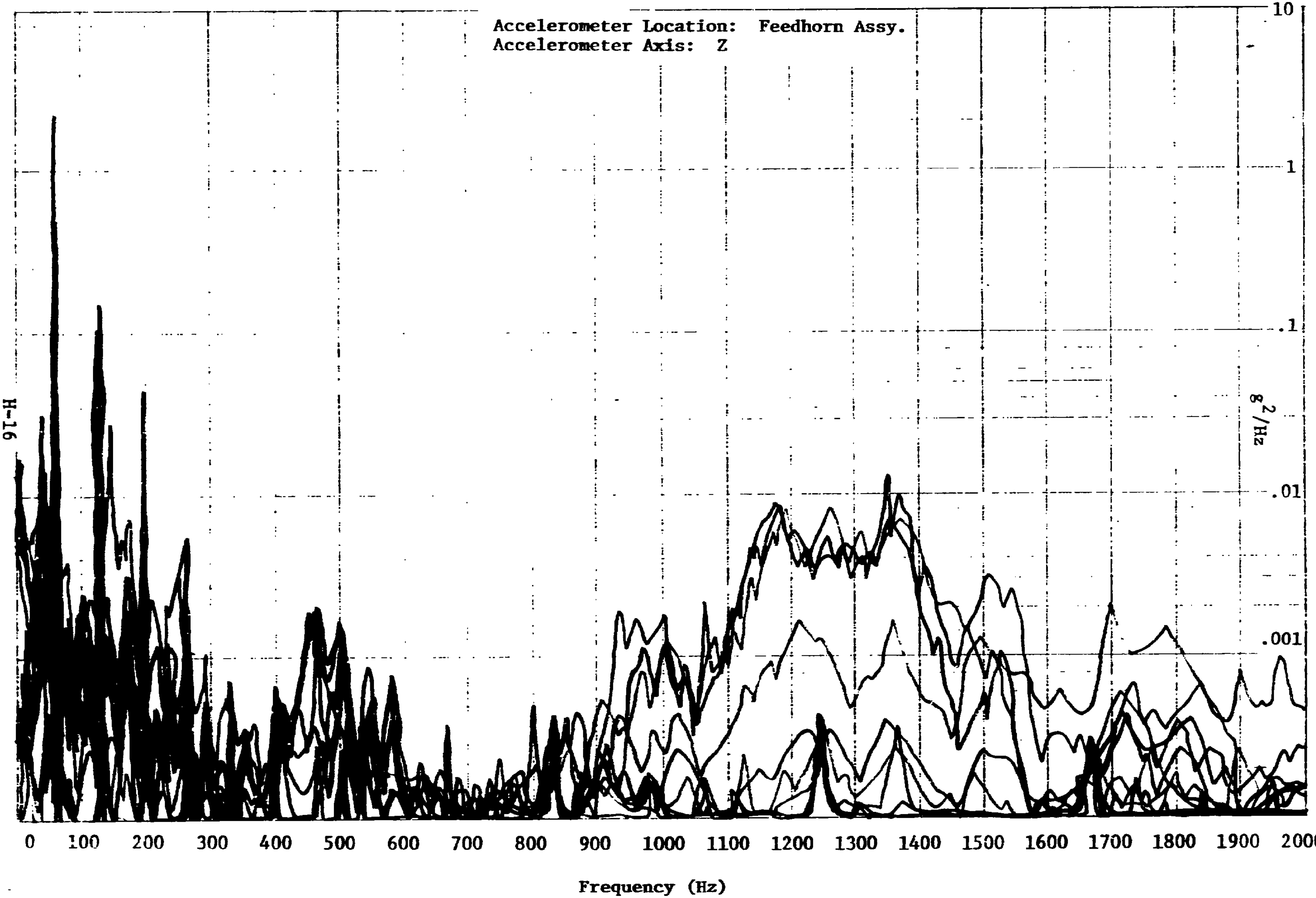


Accelerometer Location: TWT (B)
Accelerometer Axis: Z
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

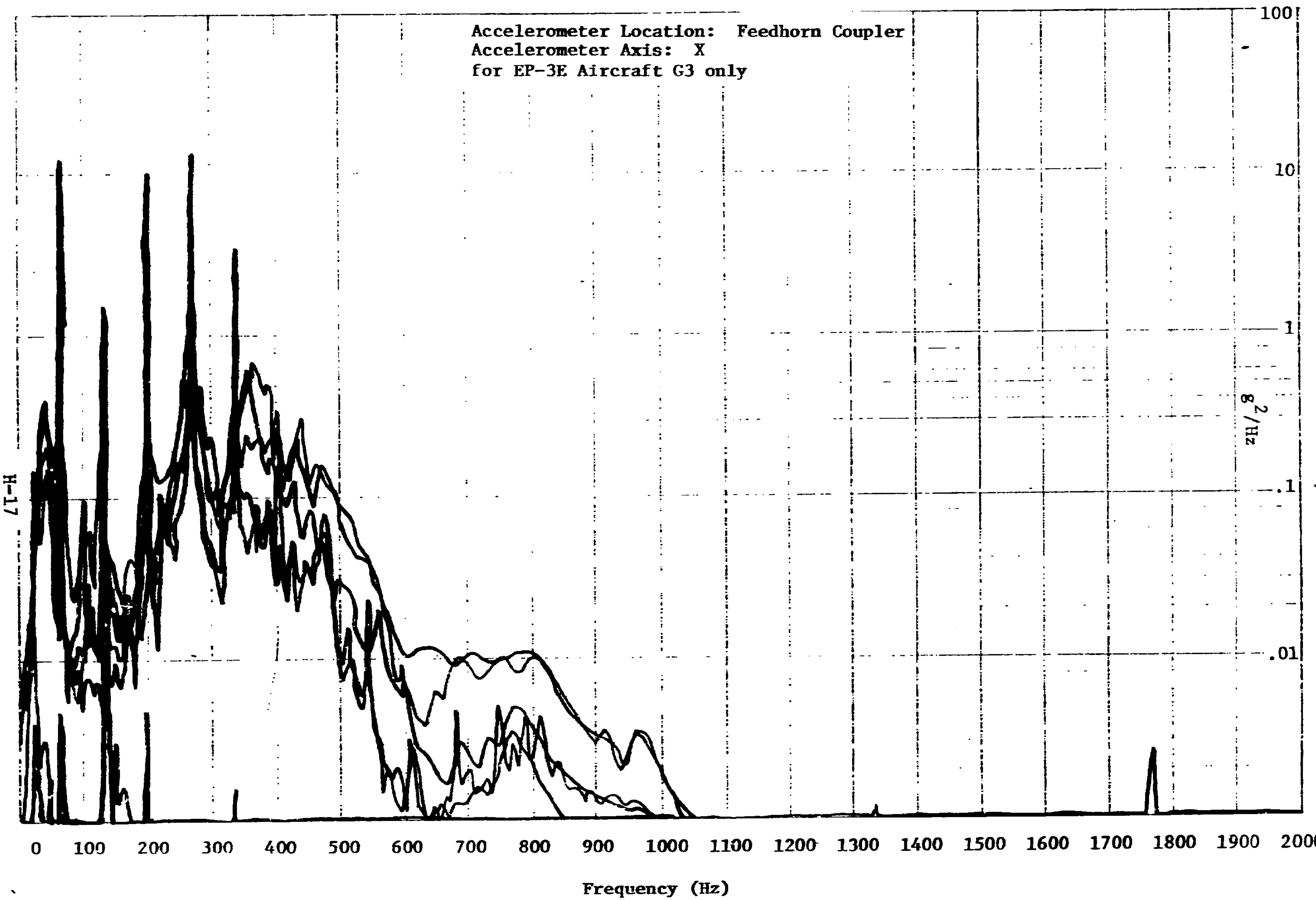


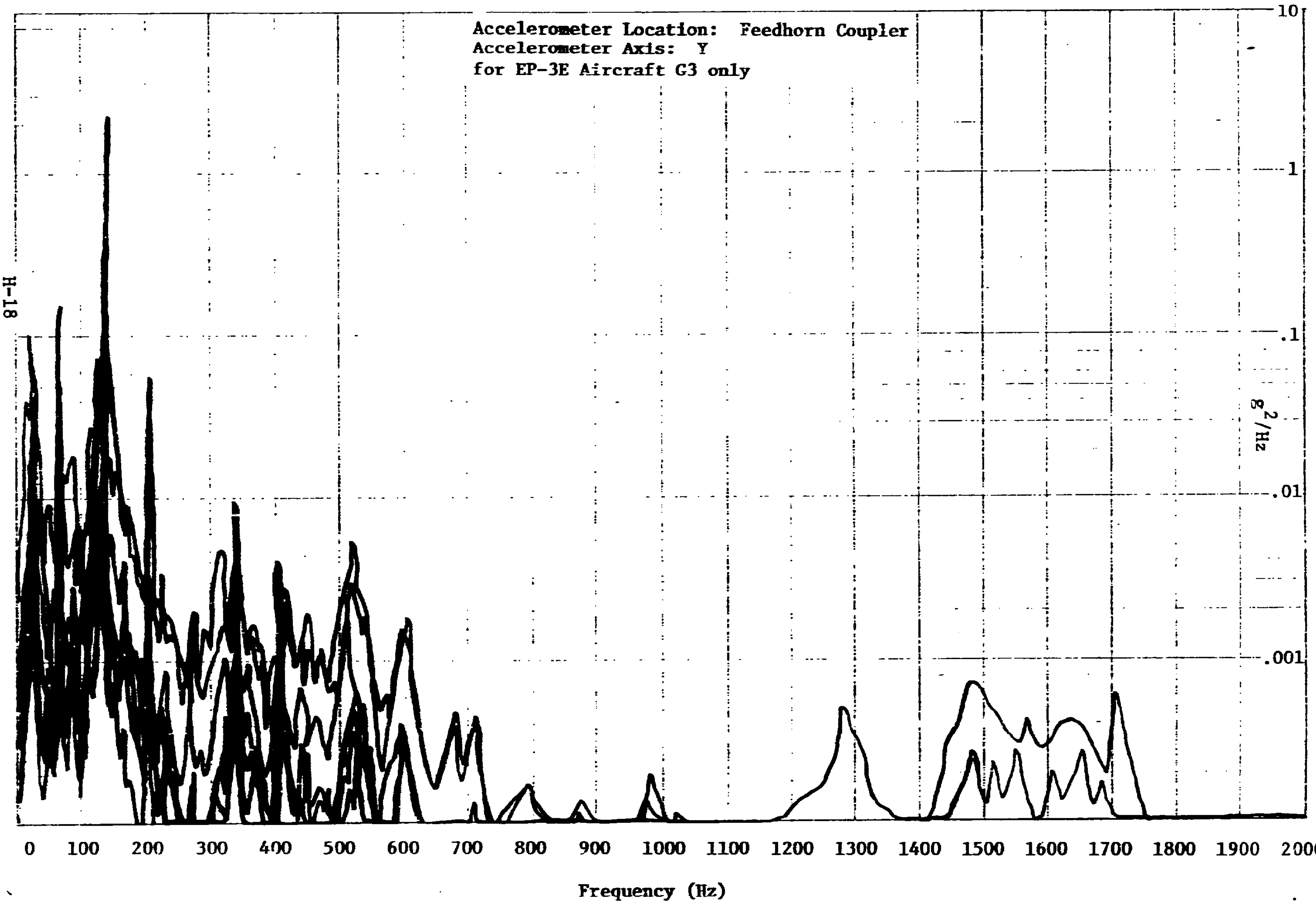
Accelerometer Location: Feedhorn Assy.
Accelerometer Axis: X
1
.1
.01
.001
.0001
g²/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)


Accelerometer Location: Feedhorn Assy.
Accelerometer Axis: Y
1
.1
.01
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

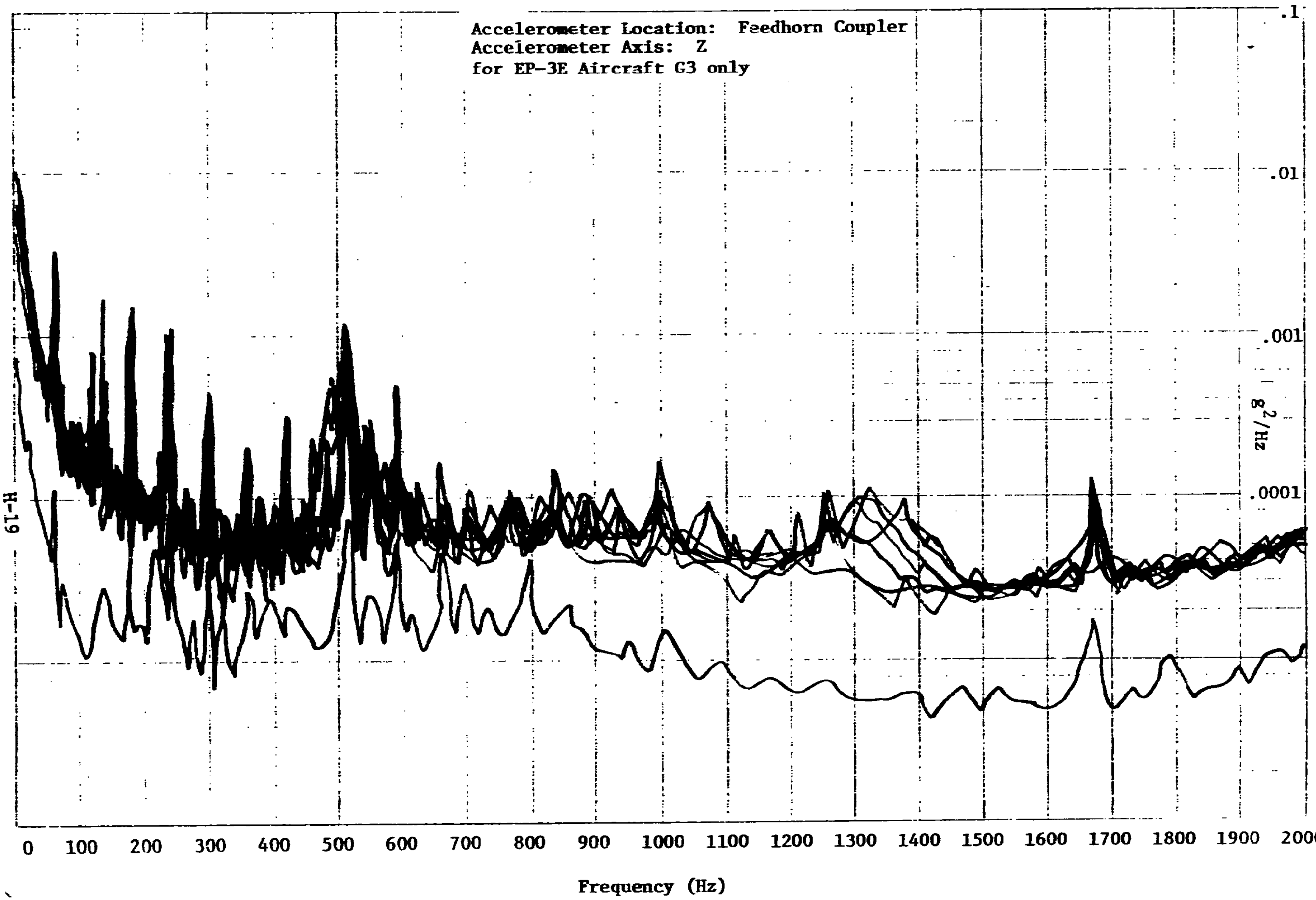


Accelerometer Location: Feedhorn Assy.
Accelerometer Axis: Z
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

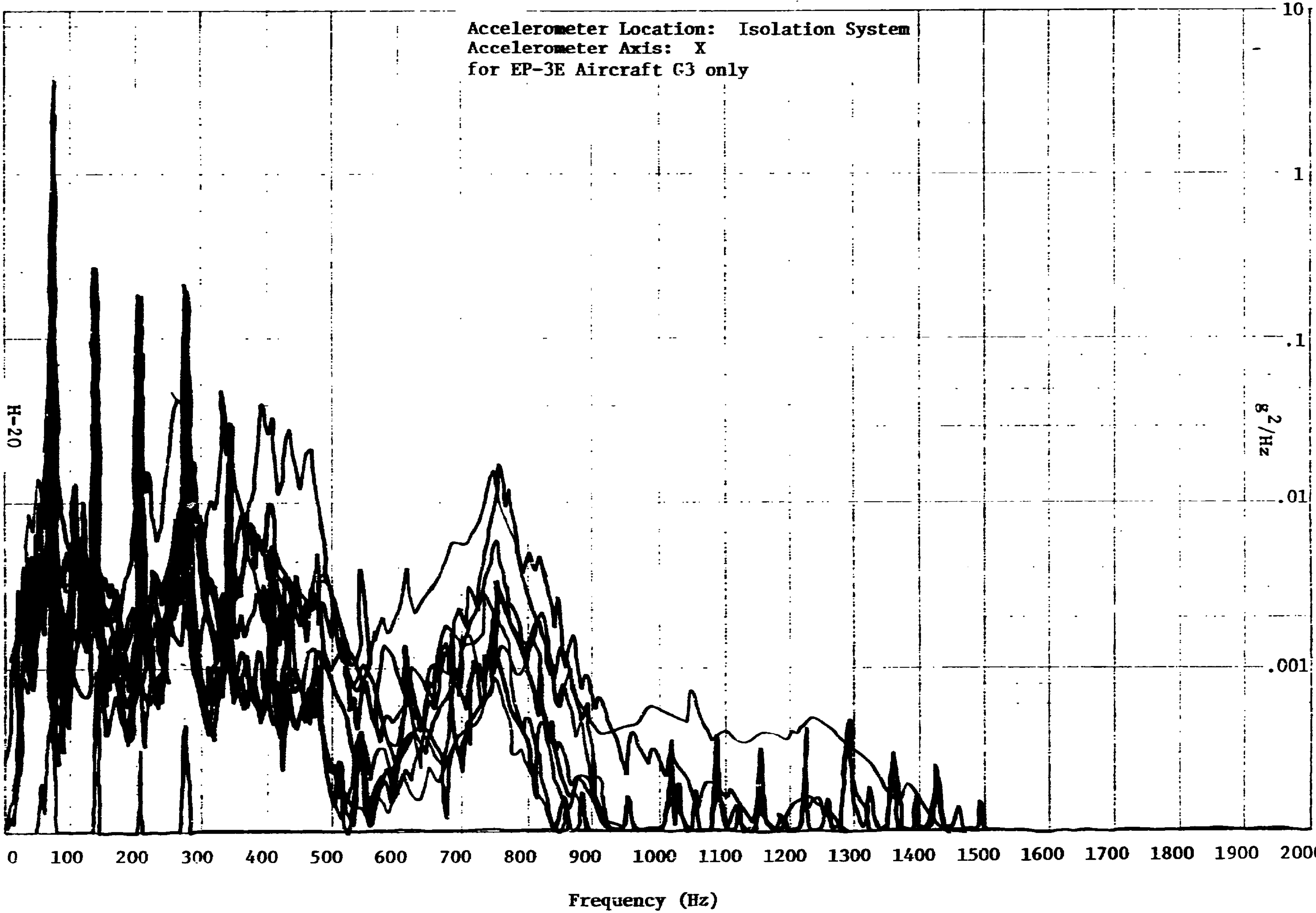

Accelerometer Location: Feedhorn Coupler
Accelerometer Axis: X
for EP-3E Aircraft G3 only
100
10
1
.1
.01
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

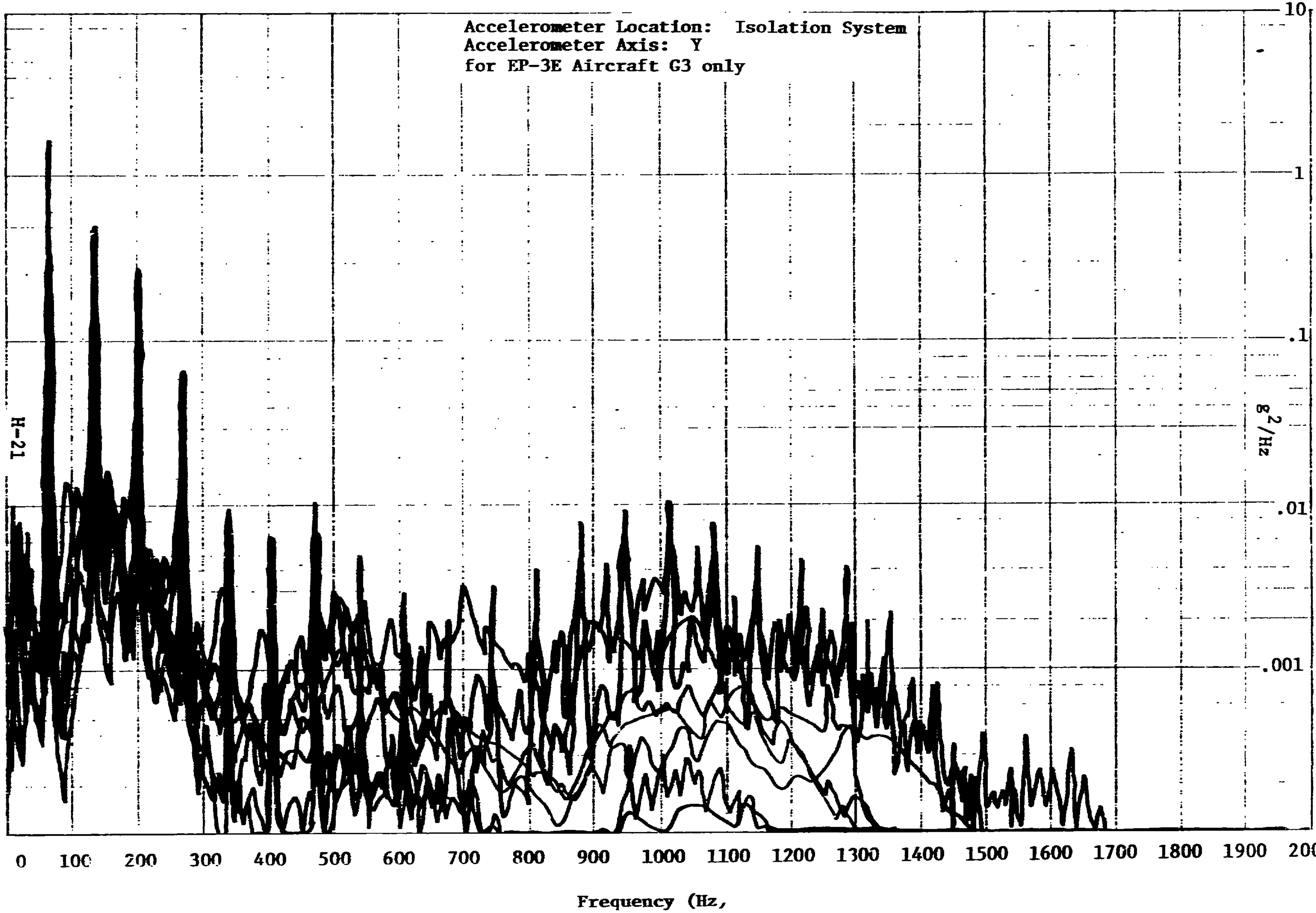


Accelerometer Location: Feedhorn Coupler
Accelerometer Axis: Y
for EP-3E Aircraft G3 only
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

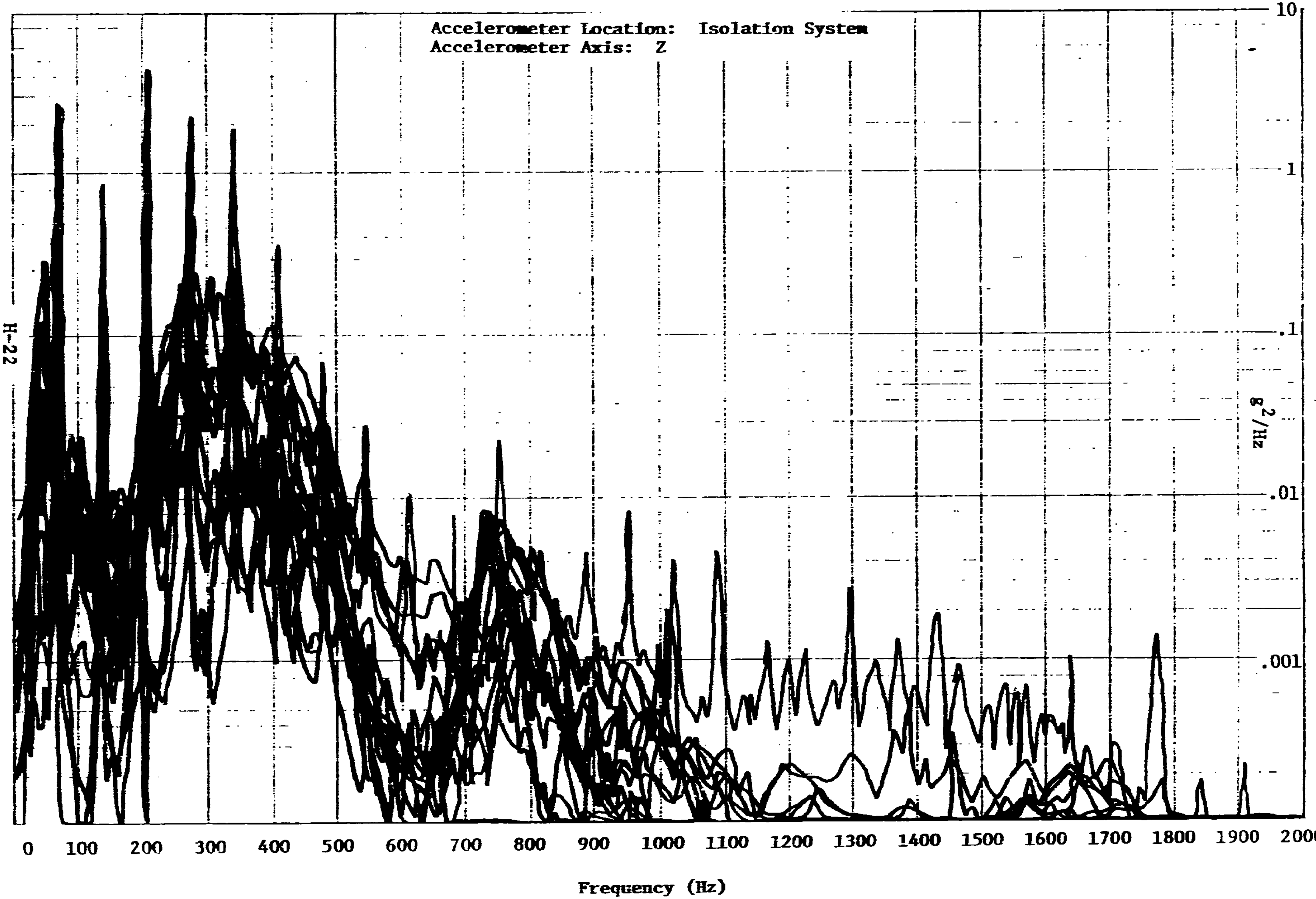


Accelerometer Location: Feedhorn Coupler
Accelerometer Axis: Z
for EP-3E Aircraft G3 only
.1
.01
.001
.0001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

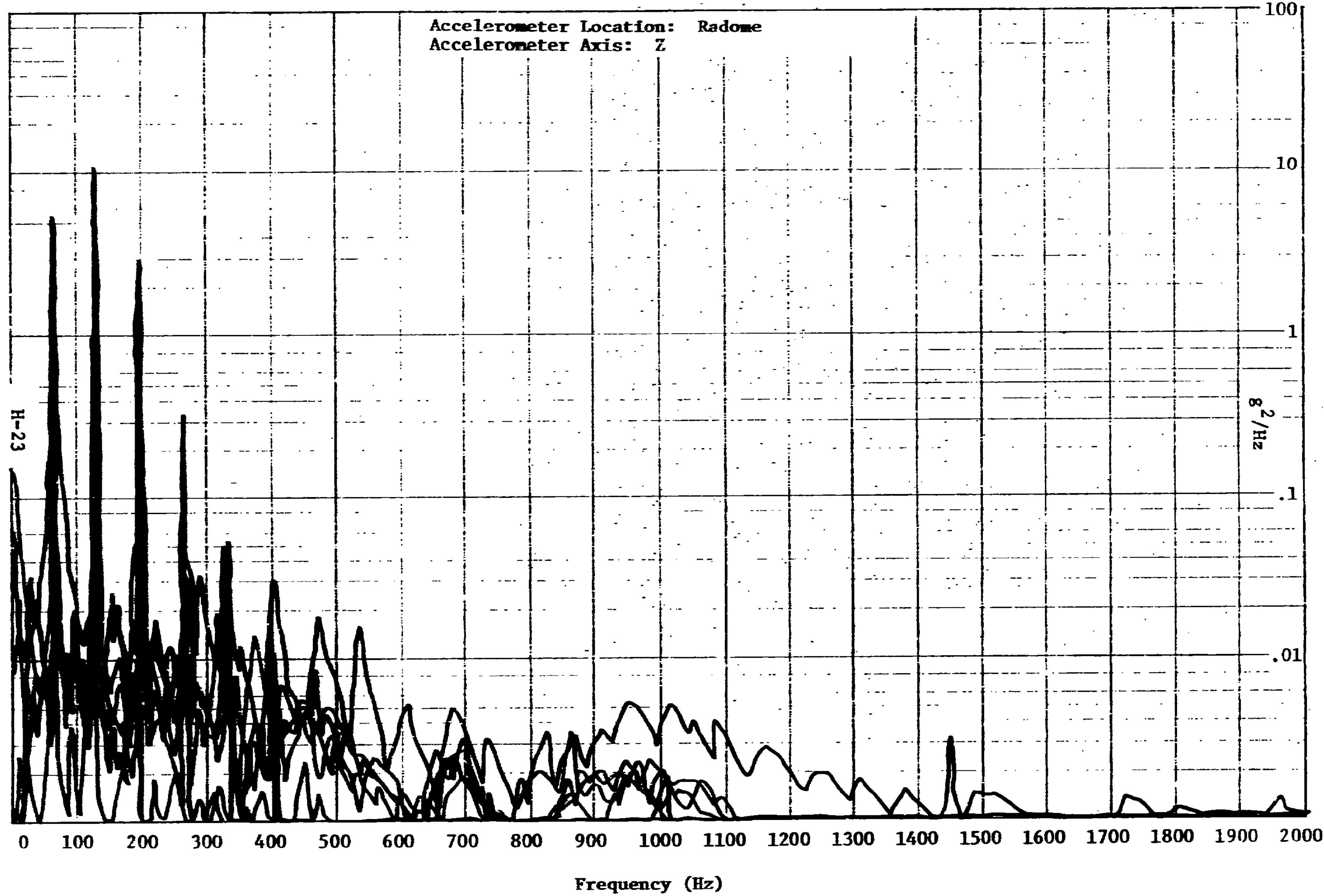

Accelerometer Location: Isolation System
Accelerometer Axis: X
for EP-3E Aircraft G3 only
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)



Accelerometer Location: Isolation System
Accelerometer Axis: Y
for EP-3E Aircraft G3 only
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
200
Frequency (Hz,



Accelerometer Location: Isolation System
Accelerometer Axis: Z
10
1
.1
.01
.001
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)


Accelerometer Location: Radome
Accelerometer Axis: Z
100
10
1
.1
.01
g^2/Hz
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Frequency (Hz)

APPENDIX I

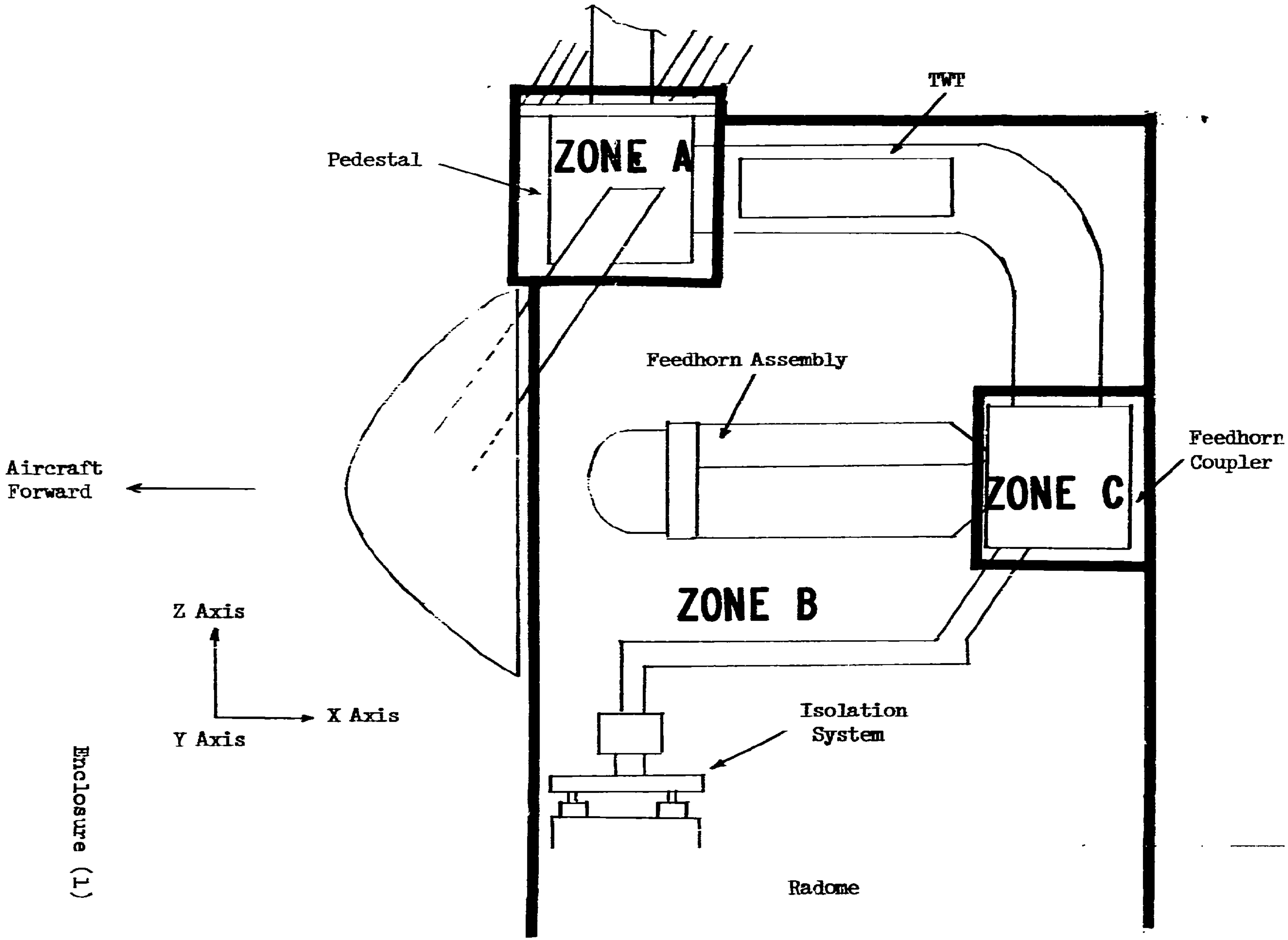
RECOMMENDED VIBRATION REQUIREMENTS

Enclosure (1) - DRAWING SHOWING THE RECOMMENDED VIBRATION ZONES FOR THE BIG LOOK ANTENNA ASSEMBLY

Enclosure (2) - RECOMMENDED TEST PROCEDURES FOR SINUSOIDAL AND RANDOM VIBRATION EXPOSURES

Enclosure (3) - RECOMMENDED VIBRATION REQUIREMENTS FOR SINUSOIDAL AND RANDOM VIBRATION EXPOSURES

FIGURE I - DRAWING SHOWING RECOMMENDED
VIBRATION ZONES FOR BIG LOOK ANTENNA ASSEMBLY



Enclosure (1)

RECOMMENDED TEST PROCEDURE FOR SINUSOIDAL VIBRATION QUALIFICATION

Components mounted as an integral part of the Big Look Antenna Assembly shall be qualified to sinusoidal vibration in accordance with the procedures set forth in MIL-T-5422F, Paragraph 4.2.2, Procedure I, Part I, and the requirements established by FIGURES IA, IB, or IC, whichever is the applicable curve for the designated vibration zone, obtained from Enclosure (1), except the following changes are required:

1. The Resonance Dwell Vibration, defined in MIL-T-5422F, Paragraph 4.2.2.1, Part I, Step 2, shall be performed for 15 minutes for each resonance versus 30 minutes. The vibration exposure time per each axis shall be two (2) hours versus three (3) hours.

2. In addition to the changes mentioned above, 30-minute resonance dwells shall be performed at each of the following frequencies: 68 Hz, 136 Hz, 204 Hz, and 272 Hz using the applicable vibration level as detailed by FIGURES IA, IB, or IC.

3. The total test time for each axis shall be four (4) hours.

The test procedures, described herein, are also applicable for qualification of the Big Look Antenna Assembly, except the Antenna Assembly shall be subjected to the vibration exposure twice. Once with the vibration input applied to the Pedestal, simulating the vibration transmitted to the Antenna Assembly from the Aircraft. The second has the vibration input applied to the base of the Lower Rotary Joint Assembly, simulating the vibration transmitted to the Antenna Assembly from the Radome.

RECOMMENDED TEST PROCEDURE FOR RANDOM VIBRATION QUALIFICATION

Components mounted as an integral part of the Big Look Antenna Assembly shall be qualified to random vibration in accordance with the procedures established by Paragraph 4.5.2 of specification MIL-STD-810B with the following exceptions:

1. The random vibration for each component shall be in accordance with FIGURE IIA, IIB, or IIC, whichever is the applicable curve as established by the mounting location.

2. The total test time for each axis shall be two (2) hours.

The test procedures, described herein, are also applicable for qualification of the Big Look Antenna Assembly, except the Antenna Assembly shall be subjected to the vibration exposure twice. Once with the vibration input applied to the Pedestal, simulating the vibration transmitted to the Antenna Assembly from the Aircraft. The second has the vibration input applied to the base of the Lower Rotary Joint Assembly, simulating the vibration transmitted to the Antenna Assembly from the Radome.

RECOMMENDED VIBRATION REQUIREMENTS FOR ZONE A

FIGURE IA

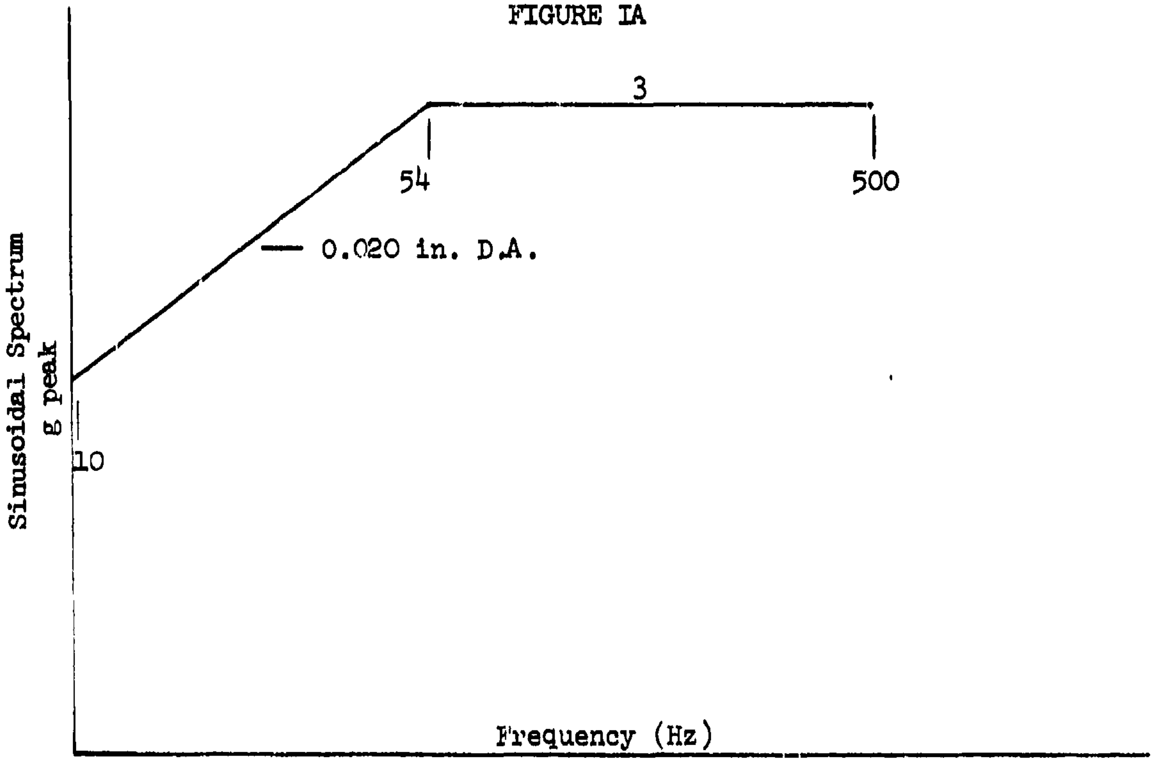
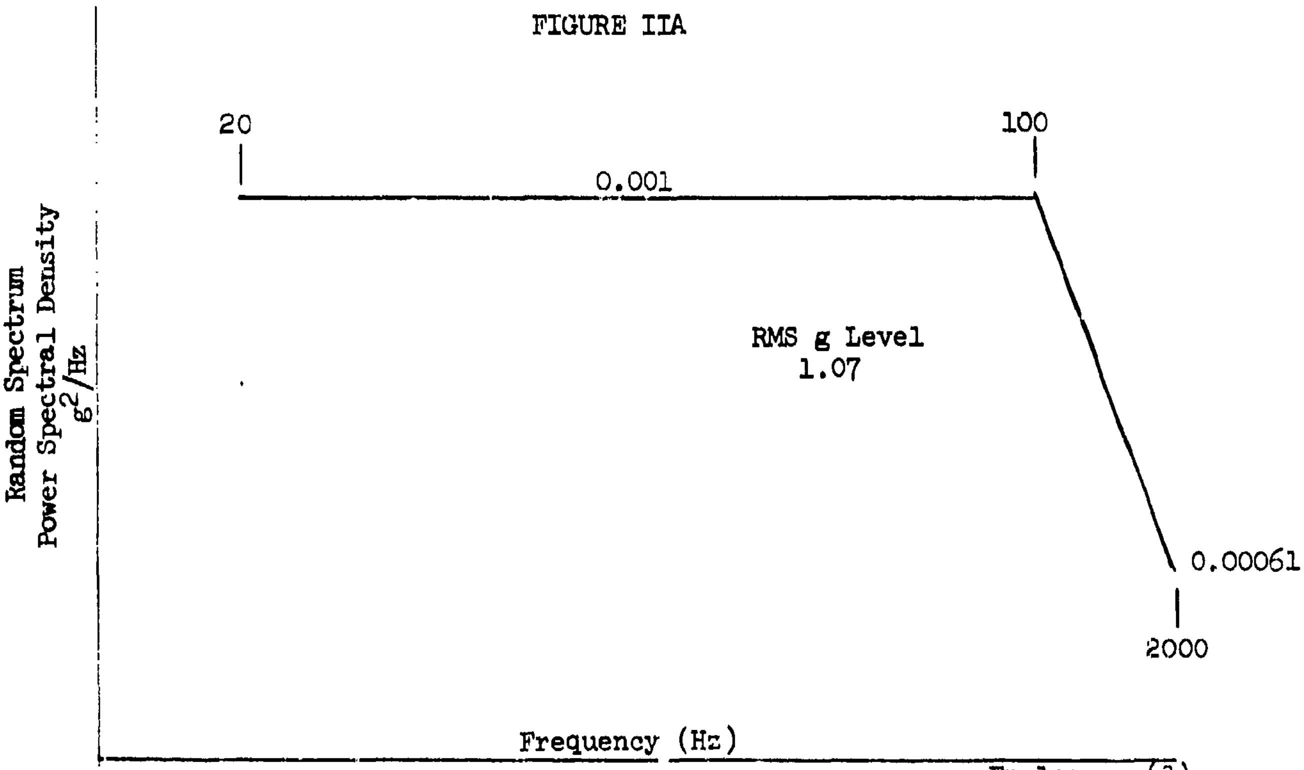


FIGURE IIA



RECOMMENDED VIBRATION REQUIREMENTS FOR
ZONE B (ALL AXES) AND ZONE C (Y AND Z AXES)

FIGURE IB

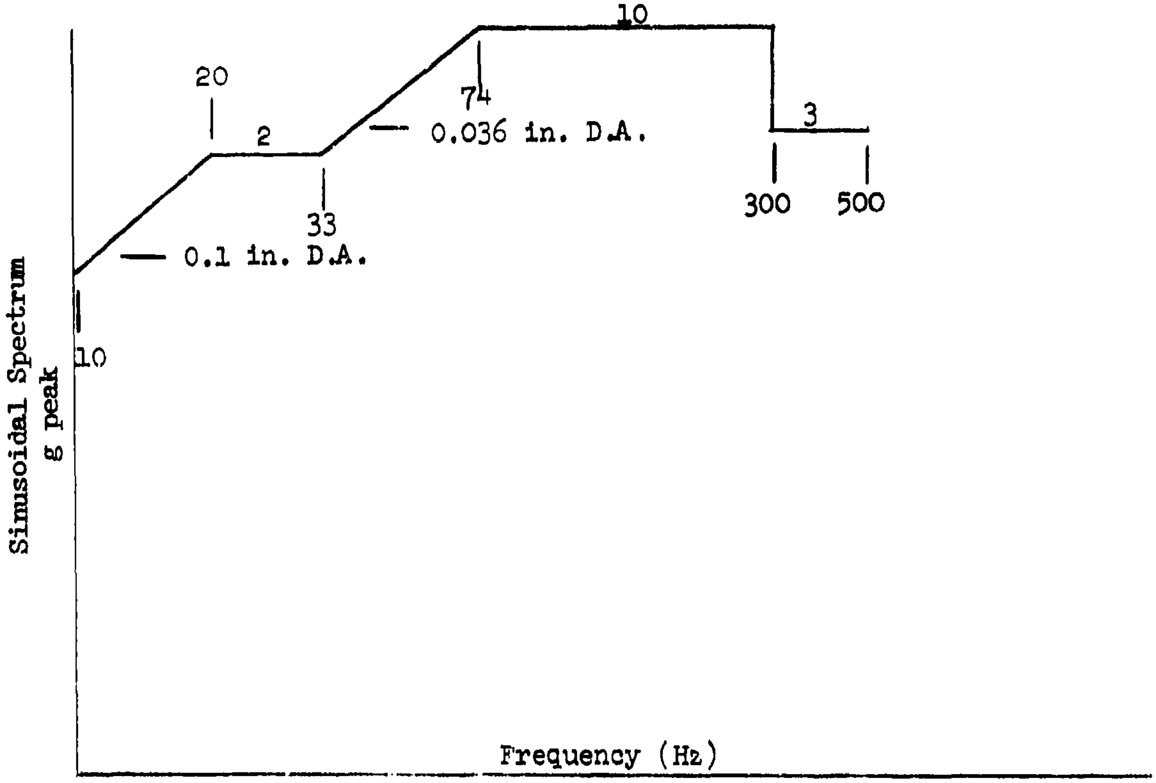
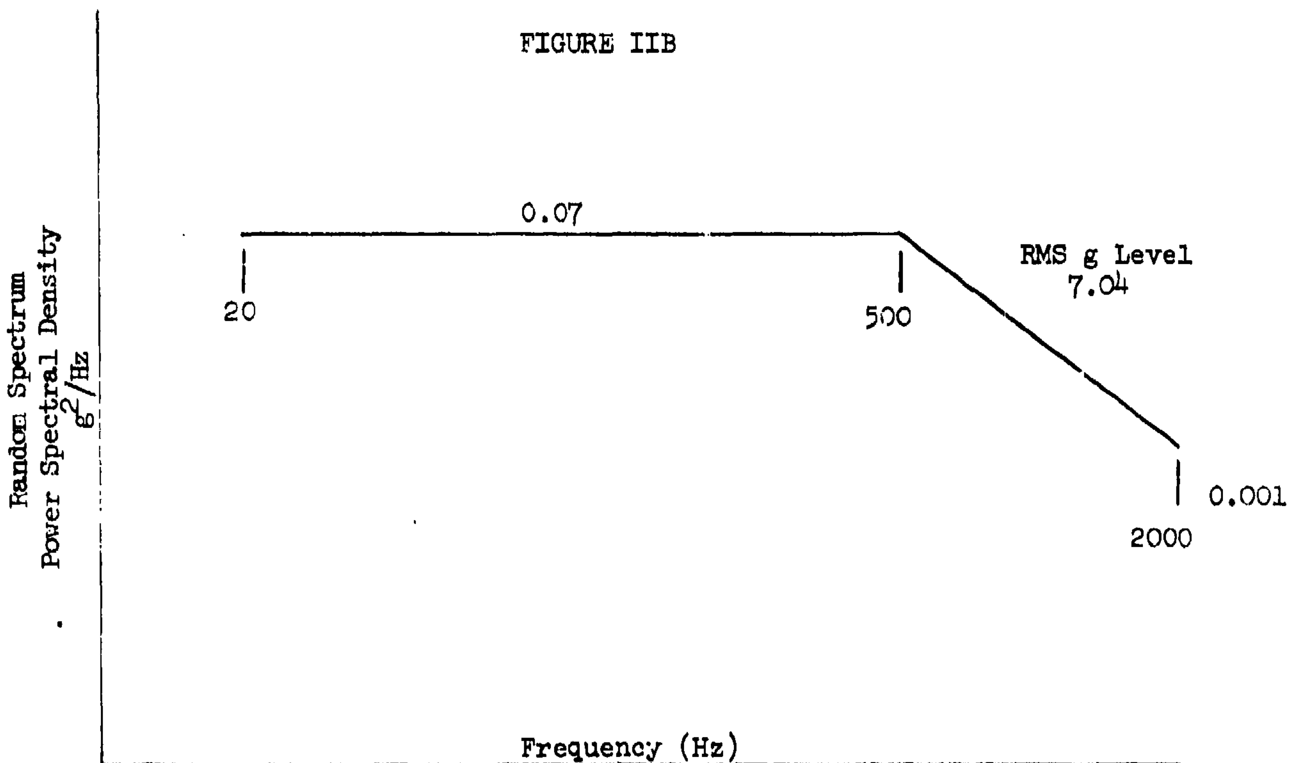


FIGURE IIB



RECOMMENDED VIBRATION REQUIREMENTS FOR ZONE C (X AXIS)

FIGURE IC

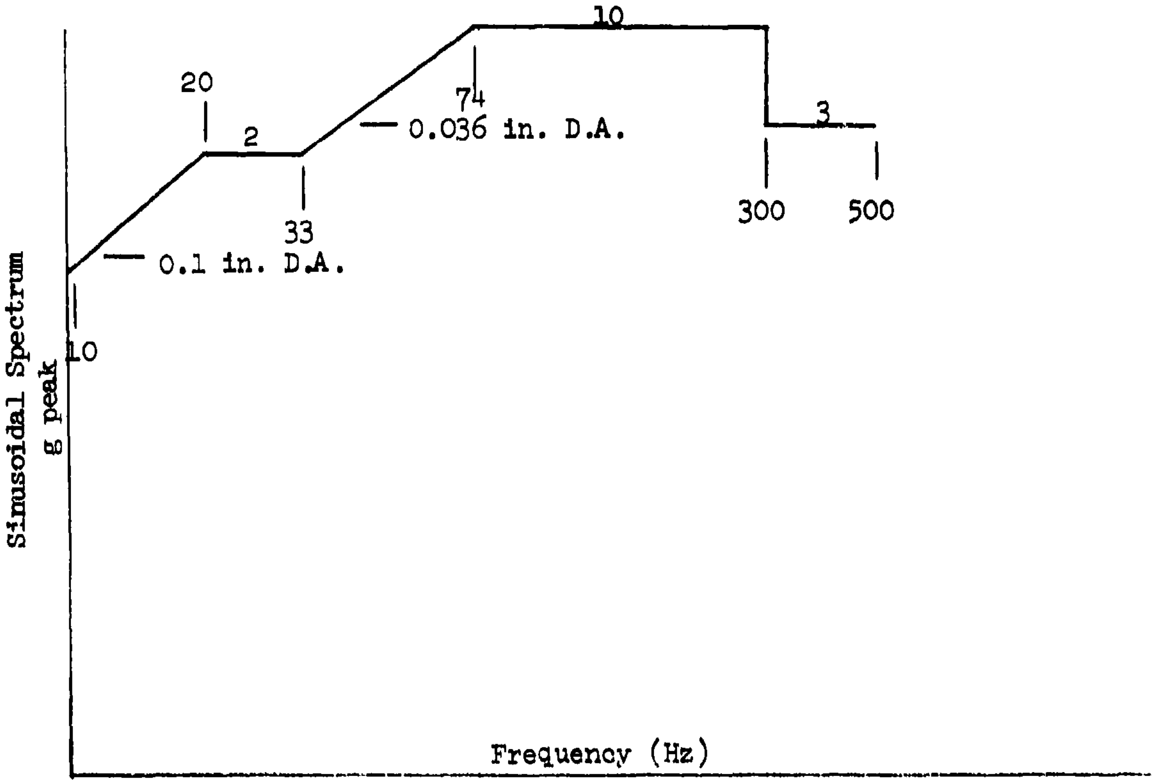
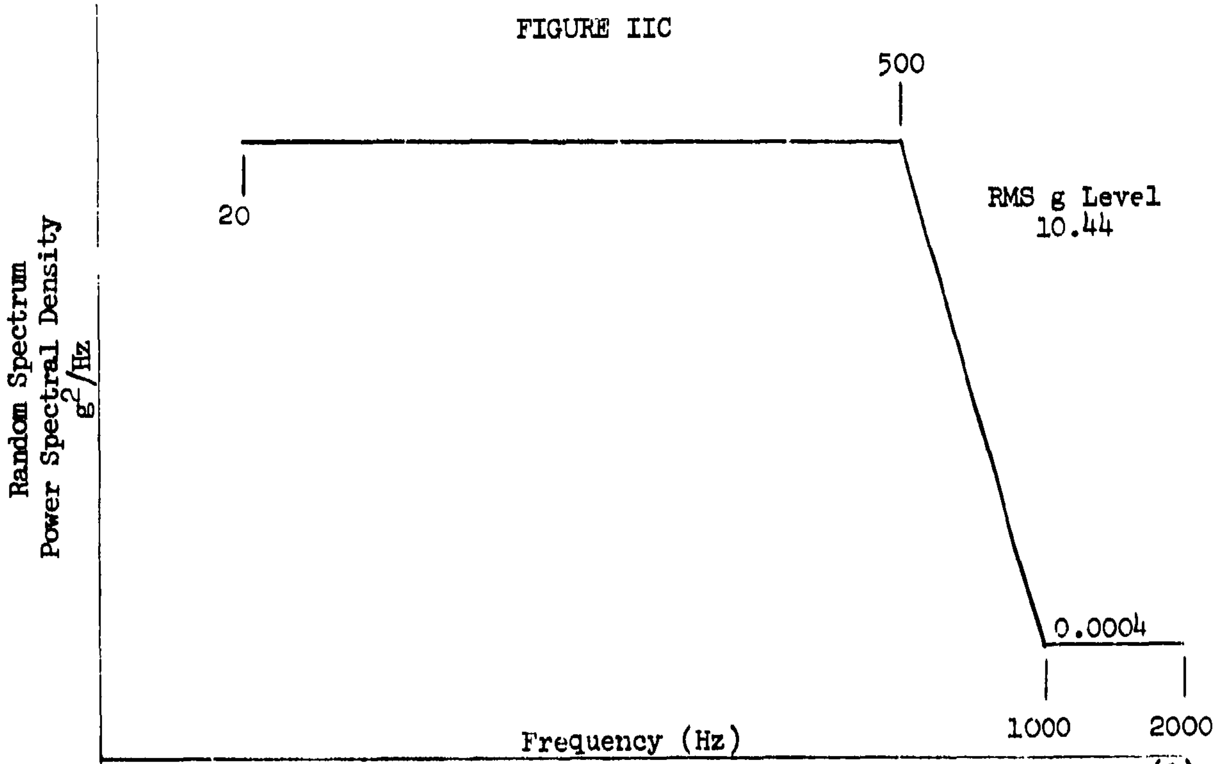


FIGURE IIC



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